SCIENCE

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THE HUMAN WORTH OF RIGOROUS THINKING[1]

> But in the strong recess of Harmony,
> Established firm abides the rounded Sphere.
> —Empedocles.

AMONG the agencies that ameliorate life, what is the rôle of rigorous thinking? What is the rôle of the spirit that aspires always to logical righteousness, seeking "to frame a world according to a rule of divine perfection"?

Evidently that question is not one for adequate handling in an hour's address by an ordinary student of mathematics. Rather is it a subject for a long series of lectures by a learned professor of the history of civilization. Indeed so vast is the subject that even an ordinary student of mathematics can detect some of the more obvious tasks such a philosophic historian would have to perform and a few of the difficulties he would doubtless encounter. It may be worth while to mention some of them.

Certainly one of the tasks, and probably one of the difficulties also, would be that of securing an audience—an audience, I mean, capable of understanding the lectures, for is not a genuine auditor a listener who understands? To understand the lectures it would seem to be necessary to know what that is which the lectures are about—that is, it would be necessary to know what is meant by rigorous thinking. To know this, however, one must either have consciously done some rigorous thinking or else, at the very least, have examined some specimens

[1] An address delivered before the Mathematical Colloquium of Columbia University, October 13, 1913.

of it pretty carefully, just as, in order to know what good art is, it is, in general, essential either to have produced good art or to have attentively examined some specimens of it, or to have done both of these things. Here, then, at the outset our historian would meet a serious difficulty, unless his audience chanced to be one of mathematicians, which is (unfortunately) not likely, inasmuch as the great majority of mathematicians are so exclusively interested in mathematical study or teaching or research as to be but little concerned with the philosophical question of the human worth of their science. It is, therefore, easy to see how our lecturer would have to begin.

Ladies and gentlemen, we have met, he would say, to open a course of lectures dealing with the rôle of rigorous thinking in the history of civilization. In order that the course may be profitable to you, in order that it may be a course in ideas and not merely or mainly a verbal course, it is essential that you should know what rigorous thinking is and what it is not. Even I, your speaker, though a historian, might reasonably be held to the obligation of knowing that.

It is reasonable, ladies and gentlemen, it is reasonable to assume, he would say, that in the course of your education you neglected mathematics, and it is, therefore, probable or indeed quite certain that, notwithstanding your many accomplishments, you do not quite know, or rather, perhaps I should say, you are very far from knowing, what rigorous thinking is or what it is not. Of course, as you know, it is, generally speaking, much easier to tell what a thing is not than to tell what it is, and I might, he would say, I might proceed by way of a preliminary to indicate roughly what rigorous thinking is not. Thus I might explain that rigorous thinking, though much of it has been done in the world, and though it has produced a large literature, is nevertheless a relatively rare phenomenon. I might point out that a vast majority of mankind, a vast majority of educated men and women, have not been disciplined to think rigorously even those things that are most available for such thinking. I might point out that, on the other hand, most of the ideas with which men and women have constantly to deal are as yet too nebulous and vague, too little advanced in the course of their evolution, too little refined and defined, to be available for concatenative thinking and rigorous discourse. I should have to say, he would add, that, on these accounts, most of the thinking done in the world on a given day, whether done by men in the street or by farmers or factory-hands or merchants or administrators or physicians or lawyers or jurists or statesmen or philosophers or men of letters or students of natural science or even mathematicians (when not strictly employed in their own subject), comes far short of the demands and standards of rigorous thinking.

I might go on to caution you, our speaker would say, against the current fallacy, recently advanced by eloquent writers to the dignity of a philosophical tenet, of regarding what is called successful action as the touchstone of rigorous thinking. For you should know that much of what passes in the world for successful action proceeds from impulse or instinct and not from thinking of any kind; you should know that no action under the control of non-rigorous thinking can be strictly successful except by the favor of chance or through accidental compensation of errors; you should know that most of what passes for successful action, most of what the world applauds and even commemorates as successful action, so far from being really

successful, varies from partial failure to failure that, if not total, would at all events be fatal in any universe that had the economic decency to forbid, under pain of death, the unlimited wasting of its resources. The dominant animal of such a universe would be in fact a superman. In our world the natural resources of life are superabundant, and man is poor in reason because he has been the prodigal son of a too opulent mother. But, ladies and gentlemen, our speaker will conclude, you will know better what rigorous thinking is not when once you have learned what it is. This, however, can not well be learned in a course of lectures in which that knowledge is presumed. I have, therefore, to adjourn this course until such time as you shall have gained that knowledge. It can not be gained by reading about it or hearing about it. The easiest way, for some persons the only way, to gain it is to examine with exceeding patience and care some specimens, at least one specimen, of the literature in which rigorous thinking is embodied. Such a specimen, he could say, is Dr. Thomas L. Heath's magnificent edition of Euclid where an excellent translation of the "Elements" from the definitive text of Heiberg is set in the composite light of critical commentary from Aristotle down to the keenest logical microscopists and histologists of our own day. If you think Euclid too ancient, and too stale even when seasoned with the wit of more than two thousand years of the acutest criticism, you may find a shorter and possibly a fresher way by examining minutely such a work as Veronese's "Grundzüge der Geometrie" or Hilbert's famous "Foundations of Geometry" or the late Pieri's "Della Geometria elementare come sistemi ipotetico-deduttivo." In works of this kind, of which the growing number is rather large, and not elsewhere, you will find, in its nakedness, purity and spirit, what you have neglected and what you need. You will note that in the beginning of such a work there is found a system of assumptions or postulates, discovered the Lord only and a few men of genius know where or how, selected perhaps with reference to simplicity and clearness, certainly selected with respect to their compatibility and independence, and, it may be, with respect also to categoricity. You will not fail to observe with the utmost minuteness, and from every possible angle, how it is that upon these postulates as a basis there is built up by a kind of divine masonry, little step by step, a stately structure of ideas, an imposing edifice of rigorous thought, a towering architecture of doctrine that is at once beautiful, austere, sublime and eternal. Ladies and gentlemen, our speaker will say, to accomplish that examination will require twelve months of pretty assiduous application. The next lecture of this course will be given one year from date.

On resuming the course what will our philosopher and historian proceed to say? He will begin to say what, if he says it concisely, will make up a very large volume. Room is lacking here, even if competence were not, for so much as an adequate outline of the matter. It is possible, however, to draw with confidence a few of the larger lines that would have to enter such a sketch.

What is it that our speaker will be obliged to deal with first? I do not mean obliged logically or obliged by an orderly development of his subject. I mean obliged by the expectation of his hearers. Every one can answer that question. For presumably the audience represents the spirit of the times, and this age is, at least to a superficial observer, an age of engineering. Now, what is engineering? Well, the charter of the Institution of Civil

Engineers tells us that engineering is the "art of directing the great sources of power in Nature for the use and convenience of man." By Nature here must be meant external or physical nature, for, if internal nature were also meant, *every* good form of activity would be a species of engineering, and may be it is such, but that is a claim which even engineers would hardly make and poets would certainly deny. Use and convenience—these are the key-bearing words. It is perfectly evident that our lecturer will have to deal first of all with what the world would call the "utility" of rigorous thinking, that is to say, with the applications of mathematics and especially with its applications to problems of engineering. If he really knows profoundly what mathematics is, he will not wish to begin with applications or even to make applications a major theme of his discourse, but he must, and he will do so uncomplainingly as a concession to the external-mindedness of his time and his audience. He will not only desire to show his audience applications of mathematics to engineering, but, being a historian of civilization, he will especially desire to show them the development of such applications from the earliest times, from the building of pyramids and the mensuration of land in ancient Egypt down to such splendid modern achievements as the designing and construction of an Eads bridge, an ocean *Imperator* or a Panama canal. The story will be long and difficult, but it will edify. The audience will be amazed at the truth if they understand. If they do not understand the truth fully, our speaker must at all events contrive that they shall see it in glimmers and gleams and, above all, that they shall acquire a feeling for it. They must be led to some acquaintance with the great engineering works of the world, past and present; they must be given an intelligent conception of the immeasurable contribution such works have made to the comfort, convenience and power of man; and especially must they be convinced of the fact that not only would the greatest of such achievements have been, except for mathematics, utterly impossible, but that such of the lesser ones as could have been wrought without mathematical help could not have been thus accomplished without wicked and pathetic waste both of material resources and of human toil. In respect to this latter point, the relation of mathematics to practical economy in large affairs, our speaker will no doubt invite his hearers to read and reflect upon the ancient work of Frontinus on the "Water Supply of the City of Rome" in order that thus they may gain a vivid idea of the fact that the most *practical* people of history, despising mathematics and the finer intellectualizations of the Greeks, were unable to accomplish their own great engineering feats except through appalling waste of materials and men. Our lecturer will not be content, however, with showing the service of mathematics in the prevention of waste; he will show that it is indispensable to the productivity and trade of the modern world. Before quitting this division of his subject he will have demonstrated that, if all the contributions which mathematics has made, and which nothing else could make, to navigation, to the building of railways, to the construction of ships, to the subjugation of wind and wave, electricity and heat, and many other forms and manifestations of energy, he will have demonstrated, I say, and the audience will finally understand, that, if all these contributions were suddenly withdrawn, the life and body of industry and commerce would suddenly collapse as by a paralytic stroke, the now splendid outer tokens of material civilization would perish, and the face of our

planet would quickly assume the aspect of a ruined and bankrupt world.

As our lecturer has been constrained by circumstances to back into his subject, as he has, that is, been compelled to treat first of the service that mathematics has rendered engineering, he will probably next speak of the applications of mathematics to the so-called natural sciences—the more properly called experimental sciences—of physics, chemistry, biology, economics, psychology, and the like. Here his task, if it is to be, as it ought to be, expository as well as narrative, will be exceedingly hard. For how can he weave into his narrative an intelligible exposition of Newton's "Principia," Laplace's "Mécanique Céleste," Lagrange's "Mécanique Analytique," Gauss's "Theoria Motus Corporum Cœlestium," Fourier's "Théorie de la Chaleur," Maxwell's "Electricity and Magnetism," not to mention scores of other equally difficult and hardly less important works of a mathematical-physical character? Even if our speaker knew it all, which no man can, he could not tell it all intelligibly to his hearers. These will have to be content with a rather general and superficial view, with a somewhat vague intuition of the truth, with fragmentary and analogical insights gained through settings-forth of great things by small; and they will have to help themselves and their speaker, too, by much pertinent reading. No doubt the speaker will require his hearers, in order that they may thus gain a tolerable perspective, to read well not only the two volumes of the magnificent work of John Theodore Merz dealing with the history of European thought in the nineteenth century, but also many selected portions of the kindred literature there cited in richest profusion. The work treats mainly of natural science, but it deals with it philosophically, under the larger aspect, that is, of science regarded as thought. By the help of such literature in the hands of his auditors, our lecturer will be able to give them a pretty vivid sense of the great and increasing rôle of mathematics in suggesting, formulating and solving problems in all branches of natural science. Whether it be with "the astronomical view of nature" that he is dealing, or "the atomic view" or "the mechanical view" or "the physical view" or "the morphological view" or "the genetic view" or "the vitalistic view" or "the psychophysical view" or "the statistical view," in every case, in all these great attempts of reason to create or to find a cosmos amid the chaos of the external world, the presence of mathematics and its manifold service, both as instrument and as norm, illustrate and confirm the Kantian and Riemannian conception of natural science as "the attempt to understand nature by means of exact concepts."

In connection with this division of his subject, our speaker will find it easy to enter more deeply into the spirit and marrow of it. He will be able to make it clear that there is a sense, a just and important sense, in which all thinkers and especially students of natural science, though their thinking is for the most part not rigorous, are yet themselves contributors to mathematics. I do not refer to the powerful stimulation of mathematics by natural science in furnishing it with many of its problems and in constantly seeking its aid. What I mean is that all thinkers and especially students of natural science are engaged, both consciously and unconsciously, both intentionally and unintentionally, in the mathematicization of concepts—that is to say, in so transforming and refining concepts as to fit them finally for the amenities of logic and the austerities of rigorous thinking. We are dealing here, our speaker

will say, with a process transcending conscious design. We are dealing with a process deep in the nature and being of the psychic world. Like a child, an idea, once it is born, once it has come into the realm of spiritual light, possibly long before such birth, enters upon a career, a career, however, that, unlike the child's, seems to be immortal. In most cases and probably in all, an idea, on entering the world of consciousness, is vague, nebulous, formless, not at once betraying either what it is or what it is destined to become. Ideas, however, are under an impulse and law of amelioration. The path of their upward striving and evolution—often a long and winding way—leads towards precision and perfection of form. The goal is mathematics. Witness, for example, our lecturer will say, the age-long travail and aspiration of the great concept now known as mathematical continuity, a concept whose inner structure is even now known and understood only of mathematicians, though the ancient Greeks helped in moulding its form and though it has long been, if somewhat blindly, yet constantly employed in natural science as when a physicist, for example, or an astronomer uses such numbers as e and π in computation. Witness, again, how that supreme concept of mathematics, the concept of function, has struggled through thousands of years to win at length its present precision of form out of the nebulous sense, which all minds have, of the mere dependence of things on other things. Witness, too, he will say, the mathematical concept of infinity, which prior to a half-century ago was still too vague for logical discourse, though from remotest antiquity the great idea has played a conspicuous rôle, mainly emotional, in theology, philosophy and science. Like examples abound, showing that one of the most impressive and significant phenomena in the life of the psychic world, if we will but discern and contemplate it, is the process by which ideas advance, often slowly indeed but surely, from their initial condition of formlessness and indetermination to the mathematical estate. The chemicization of biology, the physicization of chemistry, the mechanicization of physics, the mathematicization of mechanics, these well-known tendencies and drifts in science do but illustrate on a large scale the ubiquitous process in question.

At length, ladies and gentlemen, our speaker will say, in the light of the last consideration the deeper and larger aspects of our subject are beginning to show themselves and there is dawning upon us a wonderful vision. The nature, function and life of the entire conceptual world seem to come within the circle and scope of our present enterprise. We are beginning to see that to challenge the human worth of mathematics, to challenge the worth of rigorous thinking, is to challenge the worth of all thinking, for now we see that mathematics is but the ideal to which all thinking, by an inevitable process and law of the human spirit, constantly aspires. We see that to challenge the worth of that ideal is to arraign before the bar of values what seems the deepest process and inmost law of the universe of thought. Indeed we see that in defending mathematics we are really defending a cause yet more momentous, the whole cause, namely, of the conceptual procedure of science and the conceptual activity of the human mind, for mathematics is nothing but such conceptual procedure and activity come to its maturity, purity and perfection.

Now, ladies and gentlemen, our lecturer will say, I can not in this course deal explicitly and fully with this larger issue. But, he will say, we are living in a day when that issue has been raised; we happen

to be living in a time when, under the brilliant and effective leadership of such thinkers as Professor Bergson and the late Professor James, the method of concepts, the method of intellect, the method of science, is being powerfully assailed; and, whilst I heartily welcome this attack of criticism as causing scientific men to reflect more deeply on the method of science, as exhibiting more clearly the inherent limitations of the method, and as showing that life is so rich as to have many precious interests and the world much truth beyond the reach of that method, yet I can not refrain, he will say, from attempting to point out rather carefully what seems to me a radical error of the critics, a fundamental error of theirs, in respect to what is the highest function of conception and in respect to what is the real aim and ideal of the life of intellect. For we shall thus be led to a deeper view of our subject proper.

These critics find, as all of us find, that what we call mind or our minds are, in some mysterious way, functionally connected with certain living organisms known as human bodies; they find that these living bodies are constantly immersed in a universe of matter and motion in which they are continually pushed and pulled, heated and cooled, buffeted and jostled about—a universe that, according to James, would, in the absence of concepts, reveal itself as "a big blooming buzzing confusion"—though it is hard to see how such a revelation could happen to any one devoid of the concept "confusion," but let that pass; they find that our minds get into some initial sort of knowing connection with that external blooming confusion through what they call the sensibility of our bodies, yielding all manner of sensations as of weights, pressures, pushes and pulls, of intensities and extensities of brightness, sound, time, colors, space, odors, tastes, and so on; they find that we must, on pain of organic extinction, take some account of these elements of the material world; they find that, as a fact, we human beings constantly deal with these elements through the instrumentality of concepts; they find that the effectiveness of our dealing with the material world is precisely due to our dealing with it conceptually: they infer that, therefore, dealing with matter is exactly what concepts are for, saying with Ostwald, for example, that the goal of natural science, the goal of the conceptual method of mind, "is the domination of nature by man;" not only, our speaker will say, do our critics find that we deal with the material world conceptually, and effectively because conceptually, but they find also that life has interests and the world values not accessible to the conceptual method, and as this method is the method of the intellect, they conclude, not only that the intellect can not grasp life, but that the aim and ideal of intellect is the understanding and subjugation of matter, saying with Professor Bergson "that our intellect is intended to think matter," "that our concepts have been formed on the model of solids," "that the essential function of our intellect . . . is to be a light for our conduct, to make ready for our action on things," that "the intellect is characterized by a natural inability to understand life," that "intellect always behaves as if it were fascinated by the contemplation of inert matter," that "intelligence . . . aims at a practically useful end," that "the intellect is never quite at its ease, . . . except when it is working upon inert matter, more particularly upon solids," and much more to the same effect.

Now, ladies and gentlemen, our speaker will ask, what are we to think of this? What are we to think of this valuation of the science-making method of concepts? What are we to think of the aim and ideal

here ascribed to the intellect and of the station assigned it among the faculties of the human mind? In the first place, he will say, it ought to be evident to the critics themselves, and evident to them even in what they esteem the poor light of intellect, that the above-sketched movement of their minds is a logically unsound movement. They do not indeed contend that, because a living being in order to live must deal with the material world, it must, therefore, do so by means of concepts. The lower animals have taught them better. But neither does it follow that, because certain bipeds in dealing with the material world deal with it conceptually, the essential function of concepts is just to deal with matter. Nor does such an inference respecting the essential function of concepts follow from the fact that the superior effectiveness of man's dealing with the physical world is due to his dealing with it conceptually. For it is obviously conceivable and supposable that such conceptual dealing with matter is only an incident or byplay or subordinate interest in the career of concepts. It is conceivably possible that such employment is only an avocation, more or less serious indeed and more or less advantageous, yet an avocation, and not the vocation, of intellect. Is it not evidently possible to go even further? Is it not logically possible to admit or to contend that, inasmuch as the human intellect is functionally attached to a living body which is itself plunged in a physical universe, it is absolutely necessary for the intellect to concern itself with matter in order to preserve, not indeed the animal life of man, but his intellectual life—is it not allowable, he will say, to admit or to maintain *that* and at the same time to deny that such concernment with matter is the intellect's chief or essential function and that the subjugation of matter is its ideal and aim?

Of course, our lecturer will say, our critics might be wrong in their logic and right in their opinion, just as they might be wrong in their opinion and right in their logic, for opinion is often a matter, not of logic or proof, but of temperament, taste and insight. But, he will say, if the issue as to the chief function of concepts and the ideal of the intellect is to be decided in accordance with temperament, taste and insight, then there is room for exercise of the preferential faculty, and alternatives far superior to the choice of our critics are easy enough to find. It may accord better with our insight and taste to agree with Aristotle that "It is owing," not to the necessity of maintaining animal life or the desire of subjugating matter, but "it is owing to their *wonder* that men both now begin and at first began to philosophize; they *wondered* originally at the obvious difficulties, then advanced little by little and stated the difficulties about the greater matters." The striking contrast of this with the deliverances of Bergson is not surprising, for Aristotle was a pupil of Plato and the doctrine of Bergson is that of Plato completely inverted. It may accord better with our insight and taste to agree with the great C. G. I. Jacobi, who, when he had been reproached by Fourier for not devoting his splendid genius to physical investigations, replied that a philosopher like his critic "ought to know that the unique end of science is," not public utility and applications to natural phenomena, but "is the honor of the human spirit." It may accord better with our temperament and insight to agree with the sentiment of Diotima: "I am persuaded that all men do all things, and the better they are the better they do them, in the hope," not of subjugating matter, but "in the hope of

the glorious fame of immortal virtue."

But it is unnecessary, ladies and gentlemen, it is unnecessary, our speaker will say, to bring the issue to final trial in the court of temperaments and tastes. We should have there a too easy victory. The critics are psychologists, some of them eminent psychologists. Let the issue be tried in the court of psychology, for it is there that of right it belongs. They know the fundamental and relevant facts. What is the verdict according to these? The critics know the experiments that have led to and confirmed the psychological law of Weber and Fechner and the doctrine of thresholds; they know that, in accordance with that doctrine and that law, an appropriate stimulus, no matter what the department of sense, may be finite in amount and yet too small, or finite and yet too large, to yield a sensation; they know that the difference between two stimuli appropriate to a given sense department, no matter what department, may be a finite difference and yet too small for sensibility to detect, or to work a change of sensation; they ought to know, though they seem not to have recognized, much less to have weighed, the fact that, owing to the presence of thresholds, the greatest number of distinct sensations possible in any department of sense is a *finite* number; they ought to know that the number of different departments of sense is also a *finite* number; they ought to know that, therefore, the total number of distinct or different *sensations* of which a human being is capable is a *finite* number; they ought to know, though they seem not to have recognized the fact, that, on the other hand, the world of *concepts* is of *infinite* multiplicity, that concepts, the fruit of intellect, as distinguished from sensations, the fruit of sensibility, are *infinite* in number; they ought, therefore, to see, our speaker will say, though none of them has seen, that in attemping to derive intellect out of sensibility, in attempting to show that (as James says) "concepts flow out of percepts," they are confronted with the problem of bridging the immeasurable gulf between the finite and the infinite, of showing, that is, how an infinite multiplicity can arise from one that is finite. But even if they solved that apparently insoluble problem, they would not yet be in position to affirm that the function of intellect and its concepts is, like that of sensibility, just the function of dealing with matter, as the function of teeth is biting and chewing. Far from it.

Let us have another look, the lecturer will say, at the psychological facts of the case. Owing to the presence of thresholds in every department of sense it may happen and indeed it does happen constantly, in every department, that three different amounts of stimulus of a same kind give *three sensations such that two of them are each indistinguishable from the third and yet are distinguishable from one another.* Now, for sensibility in any department of sense, two magnitudes of stimulus are unequal or are equal according as the sensations given by them are or are not distinguishable. Accordingly in the world of sensible magnitudes, in the sensible universe, in the world, that is, of *felt* weights and thrusts and pulls and pressures, of *felt* brightnesses and warmths and lengths and breadths and thicknesses and so on, in this world, which is the world of matter, *magnitudes are such that two of them may each be equal to a third without being equal to one another.* That, our speaker will say, is a most significant fact and it means that the sensible world, the world of matter, is irrational, infected with contradiction, contravening the essential laws of thought. No wonder, he will say, that old

Heraclitus declared the unaided senses "give a fraud and a lie."

Now, our speaker will ask, what has been and is the behavior of intellect in the presence of such contradiction? Observe, he will say, that it is intellect, and not sensibility, that detects the contradiction. Of the irrationality in question sensibility remains insensible. The data among which the contradiction subsists are indeed rooted in the sensible world, they inhere in the world of matter, but the contradiction itself is known only to the logical faculty called intellect. Observe also, he will say, and the observation is important, that such contradictions do not compel the intellect to any activity whatever intended to preserve the life of the living organism to which the intellect is functionally attached. That is a lesson we have from our physical kin, the beasts. What, then, *has* the intellect done because of or about the contradiction? Has it gone on all these centuries, as our critics would have us believe, trying to "think matter," as if it did not know that matter, being irrational, is not thinkable? Far from it, he will say, the intellect is no such ass.

What it has done, instead of endlessly and stupidly besieging the illogical world of sensible magnitudes with the machinery of logic, what it has done, our lecturer will say, is this: it has created for itself another world. It has not rationalized the world of sensible magnitudes. That, it knows, can not be done. It has discerned the ineradicable contradictions inherent in them, and by means of its creative power of conception it has made a new world, a world of conceptual magnitudes that, like the continua of mathematics, are so constructed by the spiritual architect and so endowed by it as to be free alike from the contradictions of the sensible world and from all thresholds that could give them birth. Indeed conception, to speak metaphorically in terms borrowed from the realm of sense, is a kind of infinite sensibility, transcending any finite distinction, difference or threshold, however minute or fine. And, now, our speaker will say, it is such magnitudes, magnitudes created by intellect and not those discovered by sense, though the two varieties are frequently not discriminated by their names, it is such conceptual magnitudes that constitute the subject-matter of science. If the magnitudes of science, apart from their rationality, often bear in conformation a kind of close resemblance to the magnitudes of sense, what is the meaning of the fact? It means, contrary to the view of Bergson but in accord with that of Poincaré, that the free creative artist, intellect, though it is not constrained, yet has chosen to be guided, in so far as its task allows, by facts of sense. Thus we have, for one example among many, conceptual space and sensible space so much alike in conformation that, though one of them is rational and the other is not, the undiscriminating hold them as the same.

And now, our lecturer will ask, for we are nearing the goal, what then *is* the motive and aim of this creative activity of the intellect? Evidently it is not to preserve and promote the life of the human body, for animals flourish without the aid of concepts and despite the contradictions in the world of sense. The aim is, he will say, to preserve and to promote the life of the intellect itself. In a realm infected with irrationality, with omnipresent contradictions of the laws of thought, intellect can not live, much less flourish; in the world of sense, it has no proper subject-matter, no home, no life. To live, to flourish, it must be able to think, to think in accordance with the laws of its being. It is stimulated and its activity sustained by two opposite

forces: discord and concord. By the one it is driven; by the other, drawn. Intellect is a perpetual suitor. The object of the suit is not the conquest of matter, it is a thing of mind, it is the music of the spirit, it is Harmonia, the beautiful daughter of the muses. The aim, the ideal, the beatitude of intellect is harmony. That is the meaning of its endless talk about compatibilities, consistencies and concords, and that is the meaning of its endless battling and circumvention and transcendence of contradiction. But what of the applications of science and public service? These are by-products of the intellect's aim and of the pursuit of its ideal. Many things it regards as worthy, high and holy—applications of science, public service, the "wonder" of Aristotle, Jacobi's "honor of the human spirit," Diotima's "glorious fame of immortal virtue"—but that which, by the law of its being, intellect seeks above all and perpetually pursues and loves, is harmony. It is for a home and a dwelling with her that intellect creates a world; and its admonition is: Seek ye first the Kingdom of Harmony, and all these things shall be added unto you.

And the ideal and admonition, thus revealed in the light of analysis, are justified of history. Inverting the order of time, we have only to contemplate the great periods in the intellectual life of Paris, Florence and Athens. If, among these mightiest contributors to the spiritual wealth of man, Athens is supreme, she is also supreme in her devotion to the intellect's ideal. It is of Athens that Euripides sings:

The sons of Erectheus, the olden,
  Whom high gods planted of yore
In an old land of heaven upholden,
  A proud land untrodden of war;
They are hungered, and lo, their desire
  With wisdom is fed as with meat;
In their skies is a shining of fire,
  A joy in the fall of their feet;
And thither with manifold dowers,
  From the north, from the hills, from the morn,
The Muses did gather their powers,
  That a child of the Nine should be born;
And Harmony, sown as the flowers,
  Grew gold in the acres of corn.[2]

And thus, ladies and gentlemen, our lecturer will say, what I wish you to see here is, that Science, and especially Mathematics, the ideal form of science, are creations of Intellect in its quest for Harmony. It is as such creations that they are to be judged and their human worth appraised. Of the applications of mathematics to engineering and of its service in natural science, I have spoken at length, he will say, in the course of previous lectures. Other great themes of our subject remain for consideration. To appraise the worth of mathematics as a discipline in the art of rigorous thinking and as a means of giving wing to the subtler imagination; to estimate and explain its value as a norm for criticism and for guidance of speculation and pioneering in fields not yet brought under the dominion of logic; to estimate its esthetic worth as showing forth in psychic light the law and order of the psychic world; to evaluate its ethical significance in rebuking by its certitude and eternality the facile skepticism that doubts all knowledge, and especially in serving as a retreat for the spirit when as at times the world of sense seems madly bent on heaping strange misfortunes up and "to and fro the chances of the years dance like an idiot in the wind"; to give a sense of its religious value in "the contemplation of ideas under the form of eternity," in disclosing a cosmos of perfect beauty and everlasting order and in presenting there, for meditation, endless consequences traversing the rational world and seeming to point to a mystical region above and beyond: these and similar themes, our speaker

[2] Translation by Professor Gilbert Murray.

will say, remain to be dealt with in subsequent lectures of the course.

Cassius J. Keyser
Columbia University

CHEMISTRY AS AFFECTING THE PROFITABLENESS OF INDUSTRY[1]

In beginning the preparation of this paper I had thought of considering chemical industry as if it were distinct from other industries, but, as the subject developed, it became very apparent that no such distinct line could be drawn. Properly speaking, all industries must be considered as chemical. It is next to impossible to imagine the existence of an industry in which chemical reactions or considerations, either directly or indirectly, do not enter. It is possible that we could define chemical industry in a somewhat restricted sense, but such a definition would hardly be other than arbitrary. The lines of demarcation would be indistinct and shadowy. The only basis for such a definition would be the attitude of the popular mind. This attitude of mind has been steadily growing towards the recognition that chemistry is an important factor in every industry, and when, in any particular case, it becomes popularly recognized that chemistry is a factor in an industry, then that industry becomes a chemical industry. Ultimately, this popular recognition will extend to all industries and the rapidity of the growth of such recognition indicates that the time is not far distant when all industries will be generally and popularly recognized as chemical.

My plan had been to discuss the profitableness of chemical industry, but if we accept this conception that all industries are chemical, it would seem better that our discussion should be broadened so as to consider the general effect of chemistry upon the profitableness of industrial operations, using the words "industrial operations" as including all phases of the actual production of wealth.

Perhaps it would be well that I should make clear the conception that all industries are chemical in one or more phases. By way of illustration, let us consider the relation of chemistry to the production of power. I think we can show that there is a very close connection between chemistry and such production, and also that there is no industry which does not depend upon the consumption of power, and if this is the case, it becomes very evident that, from the power standpoint alone, all industries are chemical industries.

Our first impressions of power are those which we ourselves are conscious of exercising, and, in practise, the simplest form of power is man power as manifested in manual labor. It is not customary, perhaps, except from the humanitarian standpoint, to consider the chemical changes in the human body, converting food into work, as factors in industry. Nevertheless, they deserve serious consideration. It is being learned daily that properly fed employees are more efficient as workmen, and the study of food problems is surely a phase of the application of chemistry to industry. In some industries, the study of the food consumed by employees has a direct bearing upon the health of the employees as affected by the industry. It is found that certain foods act as prophylactics towards certain industrial diseases, and that other foods (perhaps improperly so called) act in the opposite manner. The scientific study of foods in connection with efficient manual labor is a phase of welfare work that has not been considered to the extent it deserves. Take, on the other hand, the horse. It is true that the horse is being

[1] Chairman's address, N. Y. Section—Society of Chemical Industry, October 17, 1913.

displaced by the locomotive and automobile, and as a power factor has been almost completely superseded by mechanical appliances; still, so far as the horse is used for the power he furnishes, his proper feeding is a phase of the application of chemistry to industry. Perhaps, it may be considered that these two illustrations, the feeding of employees and the feeding of horses, are trivial as compared with the study of the production of power through the use of the steam boiler, the steam engine, the gas producer, and the internal combustion engine. Probably this is so, for, in the production of power by these mechanical means, we have clearly recognized chemical reactions, and the understanding of these chemical reactions is essential to the proper economy of fuel and the production of power with the least outlay. In these cases, chemistry teaches us the need of a proper balancing of the combustible material used and the air supply, so that the loss of heat in effluent gases may be reduced to a minimum. In the steam boiler, chemistry has taught much of great value in relation to the refractory materials used, the utility of water consumed, and how to correct its scale-forming tendencies. In recent years, numerous excellent devices have been developed for automatically giving information as to the composition of flue gases, with the result that great savings in the cost of power have been made. The study of the composition of coals has resulted in a better classification of coals, a truer connection between price and quality, and the purchase of coals by specifications involving chemical examination is becoming more extensive each year. The small power plant can not perhaps give as much attention to chemical factors as a large plant can, but in large power plants, the economy resulting from the study of the chemistry of combustion has enabled such plants to furnish power to outsiders with a profit to themselves and to those to whom they sell it. It was chemical considerations that led to the use of blast furnace gases in the gas engine for the production of power; and if the chemist's dream comes true, there will come a time when power will be more directly produced from coal than it is to-day. It is, of course, recognized that in the utilization of the energy in our great waterfalls, chemistry is an unimportant factor, but here there is the compensating fact that many of our great chemical industries have been dependent for their existence and growth upon the cheap power thus produced.

This is as far as our time permits us to speak of the influence of chemistry upon the production of power. The scope of this paper will not allow a more detailed treatment of this subject, and what we have said is more as a matter of obvious illustration of one point of the dependence of the profitableness of industry in general upon chemical factors. If we have made this point clear, we will proceed to recount other phases of the relation of chemistry to industry.

The simplest phase is undoubtedly that which relates to the purely commercial end of industry, wherein goods are bought and sold subject to analysis, the analysis being presumed to indicate the commercial value of the goods. These goods may be in the raw state, partially finished, or finished and ready for consumption. The oldest form of this kind of analytical control was undoubtedly for the valuation of precious metals and the ores containing them. The accuracy with which gold and silver can be determined by fire assay was recognized in the early stages of metallurgical development. The fire assay corresponded on a small scale to the actual

recovery of gold and silver in smelting operations. It was natural, therefore, to assume that a similar correspondence existed between the fire assay of other metalliferous substances and the smelting operations then practised. What could be done with gold and silver, however, could not be done with the same accuracy with the more readily oxidized metals, and while the fire assay method is still applied in some places to metals other than gold and silver, in general these methods have been superseded by wet methods, which are more obviously chemical in their character, and of greater accuracy.

The chemical testing of commodities sold under specifications is primarily for the purpose of protecting the purchaser, although accuracy of testing is necessary in order that justice may be done to the seller. Practically all raw materials dealt in in quantity are sold subject to chemical analysis. Chemical analysis may not be specified in the sale or made use of by the purchaser, but, in some form or other, the purchaser has the right to test out the products received, to see whether the terms of the sale have been lived up to. Very few commodities are sold to-day in regard to which there is not some recorded information on which a purchaser can base claims, if chemical analysis shows these commodities to be different from those described in the order or contract.

If we consider, however, the whole question of the purchase of commodities on either tacit or openly acknowledged chemical requirements, we will see that chemistry has had a great influence in determining the profitableness of industry, in preventing the delivery of inferior raw or semiraw materials, which would ultimately affect the yield or quality of the finished product. The whole operation of our pure food and pure commodity laws depends upon the availability of chemical analysis and testing, and it is only natural that the rapid growth of sentiment in favor of these laws should have produced some commercial hardships, which have led to the criticism of chemical control and standards as being too rigid and unsuited to popular requirements. Nevertheless, such pure commodity laws have been of great profit to the purchasing public.

But if chemistry has had a great influence upon the profitableness of industry in the purchasing of commodities, what shall we say as to its effect on the profitableness of industry in the sale of commodities? In the popular mind, profits are made on sales, not on purchases, and the salesman seems to be, to use the language of the streets, "the whole thing." Most businesses are dominated by the salesman, be he proprietor, manager, or drummer. According to this idea, in the making of profit, the salesman is a factor greater than the purchasing agent, or even the manager of the manufacturing department, considering that these are distinct from each other. There is undoubtedly a great deal of truth in this conception, and the popular idea rests on fairly well established facts. Taking this to be the case, what has been the influence of chemistry on the sale of commodities as affecting business profits? It is generally admitted that the old-fashioned personal influence of the salesman over the sale of his goods is growing less year by year. In place of this old-fashioned personal influence is coming a newer influence in which the salesman secures his sales, not by debauching the purchaser, but by his intelligence and the helpful knowledge which he possesses about the goods he sells, and, we must add, the confidence which the purchaser has in the salesman because of his possessing that knowledge. It is no longer the general practise to keep sales-

men ignorant of processes of manufacture and use, but salesmen are being educated in many cases by technical men, often chemists, on the merits of their goods and how they may properly meet complaints. Then, too, the chemist's influence in improving the quality of products assists the salesman by giving him more saleable products. I can not take more than passing and regretful notice of the fact that there are some few chemists whose occupation appears to be mostly that of showing how goods may be debased without easy detection. The influence of the chemist in improving the quality of goods shows itself in the increased price which may be obtained for such goods. Perhaps, also, we should mention the general effect upon the commercial atmosphere of a business that has trained chemists in its employ, who give confidence to the general public that its products are made as well as can be with the assistance of the best that science can give.

Coming now to actual manufacturing operations, we will consider what the chemist has done in controlling manufacturing processes, correcting losses in manufacture, assisting in the invention of new methods and in the development of new uses for regular products, waste products and by-products. Work along this line is particularly attractive to the chemist, and, in some cases, can only be conducted profitably by the chemist. The extent to which chemical knowledge is necessary or desirable can, of course, be determined only by considering each case by itself. There are, in every case, practical limitations, in regard to which the chemist should be reasonable. Simply because, in general, chemistry is helpful, it must not, therefore, be assumed that in every case the chemist can increase the profitableness of manufacturing operations, because it must be remembered that the chemist is worthy of his hire, and that hire may more than absorb the value of what he may accomplish. In the control of manufacturing processes, if uniformity of product is desired, there is probably no one better qualified than the chemist to establish such control. This he will accomplish by the systematic study of all the materials entering into the process and the product in all stages of manufacture, discovering the chemical reactions of the process, where these reactions occur, and how they can be accelerated to advantage or made more complete, if that is desirable. Considering in the abstract the manufacturing operation involving a consumption of raw materials, heat, power, and labor, the fundamental units of cost are the time consumed and the quantity of product made. The chemist should possess an analytical mind, and, in the study of a manufacturing process, he will endeavor to develop the effect of these fundamental factors and seek to control the other cost factors, keeping in mind the preservation of the full value of the chemical reactions taking place. Chemistry has been a great help and profit to industry in the control of manufacturing losses, and the business man who fails to recognize its value can not be considered as practical. For the avoidance of such losses, the chemist is peculiarly fitted. Some industries, it is true, can be conducted profitably with large losses of some of the constituents contained in the raw materials, but, in the course of time, these losses must be controlled, for the industry that applies the best control will be the most profitable and the best able to withstand competition. This can be done only by systematic chemical examination of the materials used and by systematic study of the chemical reactions entering into the processes. But the work that chemistry does in preventing losses in manufacture is

not merely the direct prevention of such losses. Chemistry impresses itself sooner or later upon the manufacturer if he is awake, even though he be not technically trained, and he realizes that his manufacturing operations are not shrouded in mystery. The question of yield comes under the law of the conservation of matter. Matter does not disappear without going somewhere, and if it does disappear, it has been stolen, or some mistake has been made in accounting, or the matter has been changed in form, or actually lost in some of the refuse products. This is an exceedingly important subject. Many untechnical men think that yield, as they would express it, is "purely a practical question" and that losses in manufacture, like taxes and death, are something that we can not get away from. The chemist valiantly attacks this belief. He asserts that losses occur for material reasons. This attitude of the chemist is simply a rational attitude which increases very materially the profitableness of industry. In developing new uses for regular products, waste products, and by-products, the chemist has left his indelible mark upon industry. Here he is in the lead, and his constructive mind is not satisfied with announcing his immediate discoveries, but in pointing the way to the rich fields of possible discovery that lie before him.

It is proper here to elaborate a little on the value of chemical societies and their journals. Chemical societies, seeking at all times to bring out the most recent information bearing on chemical problems, obtain numerous papers, which, published in their journals, are available, in most of our large public libraries, to business men whether technically educated or not. Frequently, the information which they may want is obtained in complete form in these journals. In other cases, the information has to be interpreted by chemists, and in still other cases the information is so distantly connected with the problems involved as to be available only to chemists who open up vast possibilities of profit to industry. It is hardly to be expected that the chemist will be acquainted with all the published facts relating to any problem, but if he knows where these facts may be obtained, and if he knows how to interpret them, they soon become available, no matter how long they may have remained buried in the literature of the subject. The application of such facts frequently develops new ones, which in their turn may have high potential value. So valuable are these chemical records that I must not lose this opportunity of pointing to the great service chemists are doing and to urge them to enlarge this service to the greatest practicable degree by further contributions. The knowledge which we may possess is of value to us individually, but in the general service of mankind we can frequently impart some of this knowledge, without hurting ourselves, at the same time extending a helping hand to others.

Much has been written upon the influence of the research chemical laboratory on the profitableness of industry. Valuable information is on record showing how, in numerous cases, the research laboratory has been a tremendous profit to industry. In some cases the research laboratory is devoted almost entirely to the development of new processes and products, and it would appear that the Germans have most successfully applied this method, and that their commercial high standing in chemical manufacture has been more due to this than to any superiority in methods or economies in manufacturing. While this is true, it appears to the writer that the research laboratory has another function not usually recognized. If I were to try to

define this function of the research laboratory in popular language, I would say that it keeps the industry "ahead in the game." It is not only in the concrete things which the research laboratory does that its profitableness is to be measured, but its real value is also in the general advance work that it does. It gives to an industry a proper understanding of the needs of the trade. The industry that does not keep itself informed as to these needs is sure to lag behind. The fundamental information as to the needs of the trade can only be furnished by the chemist who has studied the possibilities, theoretical and practical, of both processes and products. The research laboratory is destroying trade superstitions, which have hindered progress. It has furnished information to salesmen which they have been able to use to practical advantage. It has been in many respects the reflective organ of industry. The research laboratory could not have been any of these things if it were not continuously studying the problem presented directly and indirectly to it and availing itself of the invaluable records preserved in our chemical journals.

In those industries involving the manufacture of chemicals or in which chemistry is a predominating and obvious influence, the chemist is, of course, appreciated, although there are many such industries which do not utilize the chemist as fully and as completely as would be to their advantage. The really successful and profitable chemical manufacturing industries avail themselves of the services of the best chemists obtainable.

The indirect influence of chemistry upon the profitableness of industry should not be overlooked. The philosopher who once said something to the effect that the man who made two blades of grass grow where only one grew before is a public benefactor, stated a truth that applies with a special force to the chemist. The discoveries of chemistry which have been of no direct value to the discoverer, but have been of great indirect value to humanity, are innumerable. Sometimes a chemist is looked upon with scorn because he has not made personal profit out of his discoveries, which he has published to the world and made common property. This form of communism is idealistic. The discoveries of Pasteur have added immense profit to the fermentation industries and have been the saving of innumerable lives. I know of no class which contributes, as chemists do, so freely to the fund of general knowledge on which profitable business is based. Then, too, there is the indirect saving which the chemist is responsible for in the conservation and utilization of industrial products. The studies relating to the corrosion of iron and steel and indeed to all of the phenomena of decay have resulted in greater permanence and durability of the products of industry, the benefits of which all industries may share.

In arguing, as we have, in favor of the proposition that chemistry is a powerful factor in making industry profitable, we must not close our eyes to its limitations. The chemist should be a business man in the best sense of the words, and should recognize that in all successful business operations a proper balancing and coordination of all its factors is necessary. The study of power problems should be made, but the extent to which expenditure for the study of power factors should be made depends upon the importance of the power factor. The testing of materials purchased and used should be made, but the extent to which such testing should be made can only be determined by the proper consideration of its relative importance. New processes and products should be developed, but

there is a limit to expenditure for these ends, which limit is in the hope of profit to be derived. After all, all industry depends upon the production or exchange of articles that are desirable, and the desirability of an article is a determining factor in its value. But not merely must a product be desirable, it must be produced with proper economy, for that is a limiting factor affecting its marketability.

We have discussed this subject in an abstract manner. Many illustrations could have been introduced of how industries have profited through the assistance of chemistry. We have thought it better, however, to omit such illustrations but hope that during the coming year we shall have many papers practically demonstrating that what we have presented in the abstract is concretely true. When we speak of chemistry as affecting the profitableness of industry, we must bear in mind that, while all chemical knowledge may be said to come from the chemist, such knowledge is often made use of with profit by those who are not chemists. This is something that is unavoidable, and it seems to me no attempt should be made to make it avoidable. The benefits which chemists derive from the more general diffusion of chemical knowledge are very much greater than would be the case if chemists were successful in an attempt to make their profession esoteric. The progress of humanity can not be accomplished by making the study of chemistry and the benefits that come from it profitable only to the chemist. It is proper that the chemist should seek to obtain profit from his knowledge and ability, but he can not hope to do this except in some few cases, unless he is willing to give to others at least a portion of the knowledge that he possesses. All industries and occupations are interdependent. All industry depends upon the chemist, and the chemist depends upon all industry. The more this interdependence is recognized, the greater the profit accruing to industry, and the greater the return to the chemist.

G. W. Thompson

INTERNATIONAL CONFERENCE ON THE STRUCTURE OF MATTER[1]

The first International Conference in Brussels on the Theory of Radiation in 1911 owed its inception to Mr. Ernest Solvay, and proved a great success. Shortly afterwards, Mr. Solvay generously gave the sum of one million francs to form an International Physical Institute (*Nature,* Vol. XC., p. 545), part of the proceeds to be devoted to assistance of researches in physics and chemistry, and part to defray the expenditure of an occasional scientific conference between men of all nations to discuss scientific problems of special interest. In pursuance of this aim the second International Conference or Conseil International de Physique Solvay, was held in Brussels this year on October 27–31, under the able presidency of Professor Lorentz. On this occasion the general subjects of discussion were confined to the structure of the atom, the structure of crystals, and the molecular theory of solid bodies.

Reports were presented by the following: The structure of the atom, Sir J. J. Thomson; Interferenzerscheinungen an Röntgenstrahlen hervorgerufen durch das Raumgitter der Kristalle, Professor Laue; the relation between crystalline structure and chemical constitution, W. Barlow and Professor Pope; some considerations on the structure of crystals, Professor Brillouin, and Molekulartheorie der Festen Korper, Professor Gruneisen.

Among those present at the meeting were Professors Lorentz, Kamerlingh Onnes, Sir J. J. Thomson, Barlow, Pope, Jeans, Bragg, Rutherford, Mme. Curie, Gouy, Brillouin, Langevin, Voigt, Warburg, Nernst, Rubens, Wien, Einstein, Laue, Sommerfeld, Gruneisen, Weiss, Knudsen, Hasenöhrl, Wood, Goldschmidt, Verschaffelt, Lindemann and De Broglie.

[1] From *Nature.*

An interesting and vigorous discussion followed on all the papers presented to the congress. Special interest was taken in the report of Laue on the interference phenomena observed in crystals with X-rays. A valuable contribution was made by Professor Bragg on selective reflection of X-rays by crystals, and on the information afforded by this new method of research on crystalline structure. The report of Mr. Barlow and Professor Pope on the relation between crystalline structure and chemical constitution was illustrated by a number of models, and was followed with much interest. A report on the papers and discussions at the conference will be published as promptly as possible.

The arrangements for the meeting, which was successful in every way, were admirably made by Dr. Goldschmidt. All the members stayed at the same hotel, and thus were afforded the best of opportunities for social intercourse and for the interchange of views on scientific questions. During the meeting, the members were very hospitably entertained by Mr. Solvay and Dr. Goldschmidt, while a visit was made to the splendid private wireless station of the latter, which is one of the largest in the world, capable of transmitting messages to the Congo and Burmah.

The committee of the International Physical Institute, who were present at the conference, held meetings to consider the applications for grants in aid of research, made possible by the sum set aside for this purpose by Mr. Solvay at the foundation of the institute.

It was arranged that the next meeting of the Conseil de Physique should be held in three years' time at Brussels, when there will be a new program of subjects for discussion. In order to extend the scope of the congress, and to make it as representative as possible, it has been arranged that the original members will retire automatically at intervals, while their place will be taken by new members, who will be specially invited to take part in discussion of definite scientific topics.

E. RUTHERFORD

THE GEOLOGICAL SOCIETY OF AMERICA

THE twenty-sixth annual meeting of the Geological Society of America will be held in Princeton, N. J., on December 30, 1913, to January 1, 1914, inclusive. The sessions of the Society will be held in Guyot Hall and the council is going to continue the plans adopted for the management of last winter's meeting. The morning sessions will be devoted to papers that promise to be of general interest; the noon recess will be long in order to give some time for social intercourse, group discussions and the examination of special exhibits; the afternoon sessions will be somewhat short and will be given over to sectional meetings and to papers of less general scope. A special room (or more than one, if needed) will be provided for the display of specimens, the hanging of charts not needed in the public reading of papers, and for similar purposes. The smoking and general conversation room or rooms will be independent of the foregoing.

The annual address of the retiring president, Professor E. A. Smith, will be delivered on the evening of Tuesday the 30th. Dr. Arthur L. Day, director of the Carnegie Institution's geophysical laboratory has consented to give an illustrated lecture on "Kilauea During the Year 1912," which was the most active period of the volcano within historic times. Dr. Day will include in his address a statement of the results of the work done at the geophysical laboratory on the gases and other material collected at Kilauea. The lecture will be given at a time to be announced later.

The council respectfully urges the fellows to consider the following points in the preparation and presentation of their papers:

1. Subjects selected for presentation should include, as far as possible, matters of general interest and wide application. Details of local problems seldom hold the attention of the audience so closely as the new aspects of general considerations which such details may exemplify.

2. The time required for presenting a paper should be not more than twenty minutes, or at the outside thirty minutes. If the speakers will carefully estimate the time actually needed

for the completion of their papers, such time will, within reasonable limits, be allowed; the speakers will then be saved from the disappointment of being interrupted before their conclusions are reached, and the officers will be relieved from the embarrassment of enforcing the rule regarding the time-limit.

3. It is particularly urged that diagrams and charts should be made on such a scale that they can be deciphered easily at a distance of 30 or 40 feet; and that lantern slides should be exhibited in moderate number, only such being chosen as directly illustrate the subject under discussion. Lantern slides should, if possible, be introduced as the points that they illustrate are reached, rather than after the conclusion of the paper.

By invitation of the fellows residing in Princeton the usual smoker or general social gathering will be held on Tuesday evening, the 30th, after the presidential address. The customary subscription dinner will take place Wednesday evening.

A valuable feature of the regular and social sessions of the annual meetings has always been the attendance of students and other junior workers in geological science, as visitors. The council desires to increase the number of such attendants, and with this object requests each fellow to send to the secretary, not later than December 10, the names and addresses of persons who, whether they can attend the meeting or not, are seriously interested in geology and deserving of recognition as visitors, although they have not yet reached such standing as to gain membership in the society. The council will then write to the persons thus nominated, inviting them to attend the Princeton meeting.

The Paleontological Society will hold its annual meeting in connection with the meeting of the Geological Society, the sessions beginning on Wednesday, December 31, 1913. Detailed information regarding this meeting may be obtained from Dr. R. S. Bassler, U. S. National Museum, Washington, D. C., Secretary of the Society.

EDMUND OTIS HOVEY,
Secretary

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

THE annual meeting of the Society will be held in Montreal, December 31, 1913, and January 1 and 2, 1914 under the presidency of Professor C.-E. A. Winslow. The meetings of the society will be held in the new Medical Building of McGill University on December 31 and January 2. The society will meet at Macdonald College on January 1, leaving Montreal at 9:10 A.M., and returning at 5:42 P.M. Luncheon will be served to the members at Macdonald College.

The annual dinner will be held at the University Club on the evening of January 1. The president's address "The Characterization and Classification of Bacterial Types" will follow the dinner.

The program is divided into topics each of which will occupy one session of the meeting. Titles of papers should be in the hands of the Program Committee not later than November 20, 1913.

Soil Bacteriology—Otto Rahn, University of Illinois, Urbana, Illinois.

Sanitary Bacteriology—including Water and Dairy Bacteriology—H. W. Hill, Institute Public Health, London, Ontario, Canada.

Systematic Bacteriology—H. J. Conn, Geneva, New York.

Technic—L. A. Rogers, Department of Agriculture, Washington, D. C.

Immunity—Benjamin White, Director of Hoagland Laboratory, Brooklyn, New York.

Pathology—P. F. Clark, No. 1027 N. Caroline Street, Baltimore, Md.

Typewritten abstracts of papers (not more than 300 words) should be in the hands of the secretary not later than the last session. These abstracts last year were published in SCIENCE and *Cent. f. Bakt.*

A. PARKER HITCHENS,
Secretary

GLENOLDEN, PENNSYLVANIA

THE ATLANTA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixty-fifth meeting of the American Association for the Advancement of Science,

and the twelfth of the "Convocation Week" meetings, will be held in Atlanta, Georgia, from December 29, 1913, to January 3, 1914.

The council will meet Monday morning, December 29, and each following morning, in the council room, at 9 o'clock. The opening general session of the association will be held at 8 o'clock on the evening of Monday, December 29. The meeting will be called to order by the retiring president, Dr. Edward C. Pickering, who will introduce the president of the meeting, Dr. Edmund B. Wilson. After addresses of welcome by Governor John M. Slaton and Mayor James G. Woodward and a reply by President Wilson, the annual address of the retiring president, Dr. Edward C. Pickering, will be given on "The Study of the Stars." After the address there will be a reception to members of the association and affiliated societies in Taft Hall.

The sections and the affiliated societies will meet daily at 10 A.M. and 2 P.M. Each section will offer a program of general interest at one or two sessions. The sections will arrange programs of special papers only when the corresponding national society does not meet at the same time and place.

The address of the retiring chairmen of the sections will be given as follows:

MONDAY AT 2 P.M.

Vice-president Locy, before the Section of Zoology. Title: "The Story of Human Lineage."

TUESDAY AT 2 P.M.

Vice-president Van Vleck, before the Section of Mathematics and Astronomy. Title: "The Influence of Fourier's Series upon the Development of Mathematics."

Vice-president Webster, before the Section of Physics. Title: "The Methods of Physical Science: to what do they Apply?"

Vice-president Johnson, before the Section of Botany. Title: "Some Botanical Contributions to the Solution of an important Biological Problem."

WEDNESDAY AT 2 P.M.

Vice-president Cattell, before the Section of Education. Title: "Science, Education and Democracy."

THURSDAY AT 2 P.M.

Vice-president Holmes, before the Section of Mechanical Science and Engineering. Title: "Safety and the Prevention of Waste in Mining and Metallurgical Operations."

Vice-president Todd, before the Section of Geology and Geography. Title: "Pleistocene History of the Missouri River."

AT 4 P.M.

Vice-president Hammond, before the Section of Social and Economic Science. Title: "The Development of Our Foreign Trade."

FRIDAY AT 4:30 P. M.

Vice-president Macleod, before the Section of Physiology and Experimental Medicine. Title: "The Physiological Instruction of Medical Students."

There will be two public lectures, complimentary to the citizens of Atlanta and vicinity, one on Tuesday evening by Dr. Charles Wardell Stiles, of the U. S. Public Health Service, on "The Health of the Mother in the South," and one on Wednesday evening by Professor Charles E. Munroe, of the George Washington University, on "The Explosive Resources of the Confederacy during the War and Now: A Chapter in Chemical History."

It is expected that there will be a number of joint meetings and the usual smokers and dinners. The Ladies' Reception Committee will arrange functions for the women members of the association and affiliated societies and for the women accompanying members. The hotel headquarters are the Piedmont. A railroad rate of one fare and three fifths for the round trip, on the certificate plan, conditioned upon the presentation at the meeting of not less than 200 certificates, has been granted by the Trunk Line Association.

The following societies have indicated their intention to meet in Atlanta during Convocation Week in affiliation with the association:

Astronomical and Astrophysical Society of America.—Will meet on dates to be announced, including joint session with Section A. Secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

Botanical Society of America.—Will meet on

Tuesday, Wednesday, Thursday and Friday, December 30 to January 2. Will hold joint sessions with Section G and American Phytopathological Association on Tuesday and Friday, respectively. Secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

American Association of Economic Entomologists.—Will meet on Thursday and Friday, January 1 and 2. Secretary, Albert F. Burgess, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.

Entomological Society of America.—Will meet on Tuesday and Wednesday, December 30 and 31. Public address on Wednesday, December 31, at 8 P.M. Secretary, Professor Alex. D. McGillivray, 603 W. Michigan Avenue, Urbana, Ill.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Will meet on Tuesday, December 30. Secretary, Dr. William A. Hedrick, McKinley Manual Training School, Washington, D. C.

American Association of Official Horticultural Inspectors.—Will meet on dates to be announced. Secretary, Professor J. G. Sanders, University of Wisconsin, Madison, Wis.

American Microscopical Society.—Will meet on Tuesday and Wednesday, December 30 and 31. Joint sessions with Sections F and G on dates to be announced. Secretary, Professor T. W. Galloway, James Millikin University, Decatur, Ill.

American Physical Society.—Will meet on Tuesday, Wednesday, Thursday and Friday, December 30 to January 2, in joint sessions with Section B. Secretary, Dr. Alfred D. Cole, Ohio State University, Columbus, Ohio.

American Phytopathological Association.—Will meet on dates to be announced. Will hold joint sessions with Section G on Tuesday, December 30, and with Botanical Society of America on Friday, January 2. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

School Garden Association of America.—Will meet on Wednesday, December 31. Secretary, Edwin J. Brown, Dayton, Ohio.

Society of the Sigma Xi.—Will hold its convention on Tuesday, December 30. Corresponding Secretary, Professor H. B. Ward, University of Illinois, Urbana, Ill.

Southern Society for Philosophy and Psychology.—Will meet on dates to be announced, including joint sessions with Section H. Secretary, Dr. W. D. Ruediger, George Washington University, Washington, D. C.

The officers for the Atlanta meeting are as follows:

President

Edmund B. Wilson, Columbia University, New York, N. Y.

Vice-presidents

A.—*Mathematics and Astronomy*—Frank Schlesinger, Allegheny Observatory, Allegheny, Pa.

B.—*Physics*—Alfred D. Cole, Ohio State University, Columbus, Ohio.

C.—*Chemistry*—Carl L. Alsberg, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

D.—*Mechanical Science and Engineering*—O. P. Hood, U. S. Bureau of Mines, Pittsburgh, Pa.

E.—*Geology and Geography*—J. S. Diller, U. S. Geological Survey, Washington, D. C.

F.—*Zoology*—Alfred G. Mayer, Carnegie Institution of Washington, Washington, D. C.

G.—*Botany*—Henry C. Cowles, University of Chicago, Chicago, Ill.

H.—*Anthropology and Psychology*—Walter B. Pillsbury, University of Michigan, Ann Arbor, Mich.

I.—*Social and Economic Science*—Judson G. Wall, Tax Commissioner, New York, N. Y.

K.—*Physiology and Experimental Medicine*—Theodore Hough, University of Virginia, Charlottesville, Va.

L.—*Education*—Philander P. Claxton, Commissioner of Education, Washington, D. C.

Permanent Secretary

L. O. Howard, Smithsonian Institution, Washington, D. C.

General Secretary

Harry W. Springsteen, Western Reserve University, Cleveland, Ohio.

Secretary of the Council

William A. Worsham, Jr., State College of Agriculture, Athens, Ga.

Secretaries of the Sections

A.—*Mathematics and Astronomy*—Forest R. Moulton, University of Chicago, Chicago, Ill.

B.—*Physics*—William J. Humphreys, U. S. Weather Bureau, Washington, D. C.

C.—*Chemistry*—John Johnston, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C.

D.—*Mechanical Science and Engineering*—Arthur H. Blanchard, Columbia University, New York, N. Y.

E.—*Geology and Geography*—GEORGE F. KAY, State University of Iowa, Iowa City, Iowa.

F.—*Zoology*—HERBERT V. NEAL, Tufts College, Mass.

G.—*Botany*—W. J. V. OSTERHOUT, Harvard University, Cambridge, Mass.

H.—*Anthropology and Psychology*—(*Acting Secretary*), E. K. STRONG, JR., Columbia University, New York, N. Y.

I.—*Social and Economic Science*—SEYMOUR C. LOOMIS, 69 Church Street, New Haven, Conn.

K.—*Physiology and Experimental Medicine*—DONALD R. HOOKER, Johns Hopkins Medical School, Baltimore, Md.

L.—*Education*—STUART A. COURTIS, Liggett School, Detroit, Mich.

Treasurer

R. S. WOODWARD, Carnegie Institution of Washington, Washington, D. C.

Assistant Secretary

F. S. HAZARD, Office of the American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

THE medals of the Royal Society have been awarded as follows: The Copley medal to Sir Ray Lankester, on the ground of the high scientific value of the researches in zoology carried out by him, and of the researches inspired and suggested by him and carried out by his pupils; a Royal medal to Professor H. B. Dixon, F.R.S., for his researches in physical chemistry, especially in connection with explosions in gases; a Royal medal to Professor E. H. Starling, F.R.S., for his contributions to the advancement of physiology; the Davy medal to Professor R. Meldola, F.R.S., for his work in synthetic chemistry; the Hughes medal to Dr. Alexander Graham Bell, on the ground of his share in the invention of the telephone and more especially the construction of the telephone receiver; the Sylvester medal to Dr. J. W. L. Glaisher, F.R.S., for his mathematical researches.

THE former pupils of Sir Henry Roscoe during the long period he occupied the chair of chemistry at Owens College, now the University of Manchester, decided some time back to commemorate the celebration of his eightieth birthday in January, 1913, by presenting his bust to the Chemical Society of London, and the formal presentation took place on November 21 at the society's rooms. Sir Edward Thorpe first presented to Sir Henry Roscoe an address signed by some 140 of his former students. He then unveiled the bust, and, on behalf of the subscribers, asked the president of the Chemical Society to accept it as a permanent memorial. He extended to Mr. Albert Drury, R.A., the thanks of the committee for the excellent and striking likeness that he had secured. He also asked Sir Henry Roscoe to accept as a further memento a replica of the bust for himself and the members of his family. The gift to the Chemical Society was accepted by the president, Professor W. H. Perkin. Sir Henry Roscoe then acknowledged the gifts, both to himself personally and to the Chemical Society.

PROFESSOR F. LOEFFLER, who since 1888 has occupied the chair of hygiene in the University of Greifswald, has been appointed director of the Koch Institute of Infectious Diseases at Berlin in succession to Professor Gaffky.

DR. J. N. LANGLEY, professor of physiology in the University of Cambridge, has been elected a corresponding member of the Munich Academy of Sciences.

THE Mary Kingsley medal of the Liverpool School of Tropical Medicine has been presented to Professor F. V. Theobald, vice-principal and zoologist of the Southeastern Agricultural College, Wye.

THE Bessemer gold medal of the British Iron and Steel Institute for 1914 will be awarded to Dr. Edward Riley, F.C.S., F.I.C.

AN appropriation from the Shaler Memorial Fund of Harvard University has been granted to Professor P. E. Raymond and Professor W. H. Twenhofel for an investigation into the correlation of the Ordovician and Silurian strata of the Baltic region with those of North America.

DR. L. W. STEPHENSON has been granted leave of absence by the U. S. Geological Survey, to occupy a chair of paleontology in the

University of California for four months, from January first.

Ernest Dunbar Clark, Ph.D. (Columbia, '10) has resigned the position of instructor in chemistry in the Cornell Medical School to accept the position of soil biochemist in the Bureau of Chemistry, U. S. Department of Agriculture.

Dr. Bruno Oetteking, who has received training in Germany and Switzerland, is working over the skull collection made in the course of the Jesup expedition of the American Museum of Natural History. The data are to be used in the final report on the physical anthropology of the expedition.

The Salt Lake City office of the mineral resources division of the United States Geological Survey was recently moved to new quarters. The addresses of the three local offices of this division in the west and the geologists in charge of them are as follows: Charles W. Henderson, 311 Chamber of Commerce, Denver Colo. Victor C. Heikes, 312 U. S. Post Office Building, Salt Lake City, Utah. Charles G. Yale, 305 U. S. Custom House, San Francisco, Cal.

Sir Aurel Stein, superintendent of the frontier circle of the archeological survey of India, has been deputed by the government of India to resume his archeological and geographical explorations in Central Asia and westernmost China, in continuation of the work he carried out between 1906 and 1908. For his journey to the border of Chinese Turkestan on the Pamirs he is taking on this occasion the route which leads through the Darel and Tangir territories, which have not been previously visited by a European.

On Friday evening, November 21, there was a public meeting in the large auditorium of the American Museum of Natural History under the joint auspices of the museum, the American Scenic and Historic Preservation Society and the National Committee for the Preservation of the Yosemite National Park, with the cooperation of many civic organizations throughout the United States to protest against the act pending in congress proposing to grant the Hetch-Hetchy Valley in the Yosemite National Park for water-storage purposes. Addresses by Professor Henry Fairfield Osborn, president of the museum; Dr. George F. Kunz, president of the Scenic Society; Mr. Robert Underwood Johnson, chairman of the National Commitee; Dr. Douglas W. Johnson, of Columbia University, and others discussed the economic, geological and scenic features of the question.

Professor Joseph Barrell, of Yale University, gave a lecture on "Some Physical Conditions which have Guided Evolution" before the Columbia Chapter of the Sigma Xi on November 25.

Professor Axel L. Melander, head of the entomological department of the State College at Pullman, Washington, spoke on "The Control of Insect Pests," before the Brown University Chapter of the Sigma Xi on November 24.

Dr. A. S. Pearse, of the University of Wisconsin lectured before the students of the department of biology at Lawrence College on November 21, his subject being "Tropical Life in Colombia." The lecture, which was an account of a recent zoological expedition of which Dr. Pearse was a member, was illustrated by lantern slides.

The Faraday Society of London devoted the meeting of November 12, 1913, to a general discussion on "The Passivity of Metals," to which it invited the following investigators to contribute papers: from England, Dr. G. Senter and Mr. H. S. Allen; from Germany, Professor Max LeBlanc (Leipzig), Professor G. Schmidt (Münster), Professor Günther Schulze (Reichsanstalt, Charlottenburg), Dr. G. Grube (Dresden); from Switzerland, Dr. D. Reichinstein (Zürich); from the United States, Professor E. P. Schoch (Austin, Texas). The papers and discussions will be printed under separate cover and also in the *Transactions* of the Faraday Society.

A lecture in memory of the late Professor Edwin Goldman was recently delivered at Freiburg University, Baden, by Professor Ashoff, who drew attention to his eminence

in surgery and to his valuable experiments in pathological anatomy.

SIR ROBERT STAWELL BALL, Lowndean professor of astronomy at Cambridge University, and director of the observatory, died on November 25, at the age of seventy-three years. He was professor of astronomy in the University of Dublin and Astronomer Royal of Ireland from 1874 to 1892, when he was called to Cambridge.

DR. HENRY POTONIÉ, geologist of the Prussian Geological Survey and professor of paleobotany in the Bergakademie, died on October 28, in his fifty-sixth year. He was widely known for his studies of paleozoic floras and for his recent work on the origin of coal.

DR. ARMIN BALZER, professor of geology and mineralogy at Berne, has died at the age of seventy-one years.

DR. EMIL PONFICK, until recently professor of pathological anatomy at Breslau, has died at the age of sixty-nine years.

SECTION F—Zoology—of the American Association for the Advancement of Science will hold meetings at Atlanta, Georgia, on Monday and Tuesday, December 29 and 30. As the American Association rarely meets in southern territory a large attendance of southern zoologists is expected, and all northern zoologists who do not expect to be present at the meetings of the American Society of Zoologists at Philadelphia are urged to support the Atlanta meeting by presenting papers. The address of the retiring vice-president of Section F, Professor William A. Locy, of Northwestern University, upon "The Story of Human Lineage" will be given on Monday afternoon, December 29, at two o'clock. Professor Edmund Beecher Wilson, professor of zoology in Columbia University, will preside over the general sessions of the association as president of the association. Titles of papers to be read before Section F should be in the hands of the secretary, Professor H. V. Neal, Tufts College, Mass., before December 15.

IT is said that the Paris Academy of Sciences has offered a prize of $2,000 to the person who devises a means for domesticating the heron in order to obtain aigrettes without killing the birds.

MR. AUSTEN CHAMBERLAIN has received from the secretary of state for India a contribution of £500 towards the enlargement and endowment of the London School of Tropical Medicine. The fund now amounts to £71,276.

IN accordance with the provision giving preference to the same candidate for three successive years, provided said candidate should have proved herself efficient and fitted for the position, the fellowship of $1,000 of the Nantucket Maria Mitchell Association for the year beginning June 15, 1914, has been awarded to Miss Margaret Harwood. The year beginning June 15, 1915, is the quadrennial year provided for by vote of the board of managers on April 26, 1911; the appointee of three previous years of continuous efficiency is privileged on the fourth to avail herself of the entire year for study and research in an observatory of her own selection. In order that the Nantucket Observatory may be provided for from June 15, 1915, to December 15, 1915, the association offers a second fellowship of $500 for the quadrennial year.

ON December 10, 11 and 12 there will be a conference on Safety and Sanitation, which will mark the opening of the first International Exposition of Safety and Sanitation, at the Grand Central Palace, New York City. The problems for discussion are:

December 10, morning—Subject, "Industrial Accidents." "Safer Shops," presented by Dr. William H. Tolman, director of the American Museum of Safety; "Human Values," by Don C. Seitz. Afternoon—Subject, "Accident Prevention and the Public." "Problems of Transportation," presented by a representative of the Pennsylvania Railroad; "Care of the Injured," by Dr. William O'Neill Sherman, chief surgeon of the Carnegie Steel Company; "Taking Chances," by Dr. Lucian W. Chaney, of the United States Department of Labor.

December 11, morning—Subject, "Industrial Hygiene." "Sanitary Welfare of Workers," by Dr. Thomas Darlington; "Physical Examination of Employees," by Dr. J. B. Hileman; "Industrial Plants, their Equipment and Surroundings," by Frank A. Wallis; "Proper Food for Workers," by

L. H. Brittain. Afternoon—Subject, "Industrial Hygiene." Chairman, Surgeon-General Charles Francis Stokes, U. S. N. "Occupational Diseases," presented by Dr. Alice Hamilton, of Hull House, Chicago; "Factory Lighting," by G. H. Stickney; "Ventilation," by Dr. D. C. Graham-Rogers; "Dental Hygiene," by Dr. Homer C. Brown.

December 12, morning—Subject, "Employer and Employee." Chairman, George B. Cortelyou. "Employer, Employee, and the Public," "What Accident Prevention means to the Worker's Family." Afternoon—Subject, "The Coming Generation." Chairman, William B. Wilson, United States Secretary of Labor. "Teaching a Child to Avoid Danger," presented by Dr. Gustave Straubenmuller, associate superintendent of New York city schools; "Changing Conditions in Municipalities," by Henry Bruere, director of the Bureau of Municipal Research.

THE second annual meeting of the Association of Alumni Secretaries was held in Chicago on November 21 and 22 with E. B. Johnson, secretary of the Alumni Association of the University of Minnesota, as president and Wilfred B. Shaw, secretary of the Alumni Association of the University of Michigan, as secretary. Representatives were present from some fifty universities and colleges. Many subjects were discussed concerned with alumni associations and the relations of alumni to their institutions. The next meeting will be held at Columbia and Yale universities in November, 1914.

THE proceedings of the eighteenth session of the International Congress of Americanists, held in London, May 27–June 1, 1912, are now ready, and will be sent to members immediately. Changes of address should be reported at once to the secretary, 50 Great Russell St., London, W. C. The work contains 566 pages of text, 50 plates, 236 illustrations in the text and 88 pages of preliminary matter, including an account of the meetings and a number of subjects of importance for the ethnography and archeology of the Americas.

AN animal reserve is to be established in Tunisia for the wild animals which are being rapidly exterminated there. For this purpose a mountainous stretch of 4,000 acres, with an adjoining marsh of 5,000 acres, has been secured near Bizerta and offers peculiarly advantageous conditions. There are already inhabiting this virgin district wild boar, hyenas, jackals, foxes, lynx, civet cat, porcupines, eagles, vultures, etc., besides many kinds of waterfowl, including a number of migratory species. The object is to isolate, so far as possible, this area, and reintroduce those species of animals which, through the spread of European civilization, has either been exterminated or driven beyond the frontier.

AN achievement of more than usual importance has been the crossing of the continent of Greenland at its widest section, which has been accomplished by the Danish expedition under Koch and Wegener last July. It will be remembered that Captain Koch commanded a division of the Danish expedition to northeast Greenland in 1906–8 and was in charge of the party which carried the exploration of the coast to the extreme northwest where a cairn left by Commander Peary was found and the eastern surveys thus connected with the western. A valuable report by Koch and Wegener upon the scientific results and especially the glaciers of that district has recently appeared and is a model of thorough and painstaking scholarship. The expedition for the crossing of Greenland was landed upon the ice of the northeast coast in July, 1912, and after an unsuccessful attempt to reach Queen Louise Land, Captain Koch decided to winter upon the inland ice. During a sledge expedition to Queen Louise Land at the end of October, the leader had the misfortune to break his leg through falling into a crevasse, and was in consequence laid up for three months. During the winter the temperature was generally fifty degrees below the freezing point and only in March could sledge work be resumed. On April 20, 1913, the expedition started to cross the continent with five sledges and five horses. During the first forty days the weather was extremely bad. On July 11 the last horse but one had to be killed, but on the next day the land of the west coast was sighted. Food now having given out and the

weather being extremely bad, the party remained for thirty-five hours without food under the shelter of a rock. Too exhausted to proceed, the explorers killed their dog and were about to eat the flesh when they saw a sailing boat on the fiord east of Proeven (near Upernivik in latitude 72° N.). By means of shots and signals they were able to attract the attention of those on board, by whom they were taken to Proeven. The expedition met one misfortune after another, and that the leaders under all discouragements pushed the undertaking through along original lines supplies a most remarkable record of courage, persistence and endurance. Some of their horses escaped, Dr. Wegener had the misfortune to break a rib and Captain Koch a leg which kept him in bed for three months. They started out upon the crossing on April 20, but their progress was much impeded by powerful westerly winds and driven snow which caused the pack horses much suffering. The last nunatak (rock island within the ice) of the group on the east coast was passed in longitude 27° west. The greatest altitude of the ice dome was met in longitude 42° west or on the western side of the medial line of the continent whereas all crossings hithertofore have shown the highest point of the ice dome to be to the eastward of the medial line. The land of the west coast was first sighted on July 2, but the surface streams and morasses of thaw-water offered such difficulties that two weeks longer were required to make the coast, the last horse and the last dog being killed for food. The junior leader of the expedition, Dr. Wegener, is a meteorologist of reputation and has published many monographs and a general text upon the free atmosphere. According to the *Geographical Journal,* from which many of these data are gleaned, the highest point along the route of the expedition was about 9,000 feet above sea level.

UNIVERSITY AND EDUCATIONAL NEWS

The Massachusetts Institute of Technology will receive about $100,000 as the residuary legatee of the late Frederick W. Emory, of Boston.

A bequest of approximately £250,000, is made in the will of the late Mr. W. Gibson, of London and Belfast, to institute a scheme for providing sons of farmers of counties Down and Antrim with educational advantages.

Professor John Perry, of the Royal College of Science, South Kensington, has been appointed a member of the South African University Commission which is to investigate matters connected with higher education and to consider the conditions under which the Wernher and Beit donations and bequests for the purposes of the proposed University of South Africa may best be utilized. The other members of the Commission are Sir Percival Maitland Laurence, formerly judge president of the Supreme Court of South Africa, who is the chairman, ex-Justice Melius de Villiers and the Rev. Mr. Bosman.

Mr. Alan G. Harper, of Magdalen College, Oxford, demonstrator to the Sibthorpian professor of rural economy, has been appointed to the Indian Education Service as professor of botany at the Presidency College, Madras, during the absence on leave of Professor Fyson.

Mr. Alexander McKenzie, head of the chemistry department of Birkbeck College, London, has been appointed professor of chemistry in University College, Dundee, in succession to the late Professor Hugh Marshall.

DISCUSSION AND CORRESPONDENCE

A PROPOSED RE-ARRANGEMENT OF SECTIONS FOR THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

One feature of the American Association for the Advancement of Science meetings which causes some inconvenience, to say the least, especially in recent years since the average attendance has passed the thousand mark, is the congested and heterogeneous character of the sectional programs. In some of the sections, as at present constituted, the large number of papers offered makes it necessary to restrict or eliminate discussions, thus defeating the main object of reading a scientific paper

to a critical audience before publishing it. Worse still, science is now so diversified and specialized that with only a dozen sections to cover the whole field no one person can appreciate all the papers read in any of the more populous sections, so that one who wants to be sure to hear a certain paper must often sit through several others which mean nothing to him.

For this state of affairs there are several possible remedies, each of which, of course, has some disadvantages. The one which seems most promising is to increase the number of sections. The organization of the Association to-day is not very different from what it was thirty years ago, although since that time several essentially new sciences have claimed recognition and some of the older ones have developed wonderfully. Incidentally the present sectional classification does not discriminate clearly enough between the true or pure sciences and the applied sciences or arts.

Some of the sections already divide into two or more groups with simultaneous programs at the annual meetings, and it is but a step farther to make the separation final, as was done, for example, when the biological section was divided into zoology and botany about twenty years ago. The council of the association at the Cleveland meeting last winter took steps in the right direction by establishing one new section, and proposing an amendment which when adopted will give them the power to create additional sections when desired.

The sections as they will be at the Atlanta meeting are as follows:

A. Mathematics and Astronomy,
B. Physics,
C. Chemistry,
D. Engineering,
E. Geology and Geography,
F. Zoology,
G. Botany,
H. Anthropology and Psychology,
I. Social and Economic Science,
K. Physiology and Experimental Medicine,
L. Education,
M. Agriculture.

Some of the apparent defects of this arrangement may be pointed out before a new one is proposed.

Comparatively few purely mathematical papers have been presented at recent meetings; but mathematics, if included in the American Association for the Advancement of Science at all, should theoretically have a separate section, for it is the foundation of all the exact sciences, and apparently no more closely connected with astronomy than with physics, engineering or logic. Astronomy too should be independent, unless its followers are too few to constitute a separate section. (Possibly some papers on optics and spectrum analysis could be diverted to it from Sections B and C to make up the deficiency, if necessary.) In the smaller colleges it is usually combined with physics rather than with mathematics.

Engineering is not a science in the same sense that physics, geology, etc., are, but rather a group of arts, based mainly on mathematics and physics. Such engineering papers as do not embody distinct contributions to the laws of physics or some other science might well be diverted to the programs of the various engineering societies. An engineer's specialty, like that of any other artisan, is knowing *how*, rather than *why;* and probably most engineers do not regard themselves as scientists at all.

Combining geology and geography in one section is convenient for those geologists who are interested in some phase of geography, and for those geographers whose chief interest is that phase of ecology which deals with the influence of land forms on human activities, but is hardly fair to the explorers, teachers of elementary geography, phytogeographers, zoogeographers and anthropogeographers, who are becoming more numerous every year, and some of whom are doing excellent work without making much, if any, use of geology. Geography certainly now deserves a separate section, as it has had in the British Association for over forty years. Some may still contend that it is not an independent science; but the same could be charged to chemistry, which is analogous to geography in some respects. For chemistry considers the chemical

composition of everything, and the properties of the elements and compounds, while geography in the strictest sense considers the areal *distribution* of everything on the earth's surface, and the properties—so to speak—of all the natural divisions of the earth.

Although it has been but a score of years since the zoological and botanical sections were separated, present conditions seem to call for further subdivision of each. Botany, for example—and a similar statement could be made with respect to zoology—is not a single science, but a group of sciences (plant taxonomy, physiology, geography, etc.), differing widely in point of view, method of treatment and personnel of followers, and having in common only the fact that they all deal with the vegetable kingdom, just as the distinct sciences psychology, anthropology, ethnology, sociology and economics all pertain to the human race.

At the same time an additional section ought to be provided for a class of investigations which has come into prominence since the beginning of the present century, namely, those dealing with mutation, Mendelism and other evolutionary problems. Some papers in this category have been presented to Section F, some to Section G, and some to joint meetings of the two. To a new section for this group might be assigned the much-abused term "biology." Biology was for a long time, and is still in some quarters, regarded as merely the sum of zoology and botany or, worse still, a mixture of a large amount of zoology with a small amount of botany.[1] Some also have treated it as practically synonymous with ecology, particularly animal ecology. But every science is known by its laws, and if biology is defined as the science of life its laws are those which apply to all forms of life and not to inanimate matter, namely, the laws of evolution and heredity.

[1] At this point some readers might be interested to turn back twenty years and read the discussion on "the emergence of a sham biology in America," begun by Professor MacMillan in SCIENCE for April 7, 1893, and continued by others in later numbers of the same volume. Dr. Ramaley's note on "What is Biology?" in SCIENCE for January 12, 1912, is also of interest in this connection.

Many if not most scientists are teachers, and consequently it is natural that when they assemble in large numbers some of them should wish to have formal discussions of educational problems, professors' salaries, university government, etc. But teaching is not a science, but an art, more closely connected with psychology than with any other science; and there are already quite a number of associations organized for the purpose of considering educational questions that lie outside the field of science.

Agriculture is another art, or group of arts, based mainly on plant physiology and ecology. However, the newly created section for agricultural science will be a convenient place for papers on fertilizers, soil toxins, etc., which in recent years have been offered in considerable numbers to Section C, the most crowded of all—or even to Section G—on soil formation and classification, a branch of geology in which very few geologists are interested, and on the physiology and ecology of cultivated crops, a somewhat neglected branch of botany.

The following table is now submitted as an illustration of how the number of sections might be advantageously increased. No doubt it has many shortcomings, which will be immediately apparent to others, and criticism of it will be welcomed. It is divided into two columns, the first containing the names of the sciences and the second a few arts correlated with them, the latter being mentioned mainly to illustrate the contrast between science and art, and the kinds of papers that might be admitted to the sectional programs whenever there happened to be a dearth of genuine scientific material. It is scarcely necessary to remark that the list of arts is much less complete than that of sciences.

SCIENCES	ARTS
Astronomy.	Chronometry. Navigation.
Physics and mechanics.	Hydraulics. Aeronautics. Optics. Mechanical and electrical engineering.

Inorganic chemistry.	Metallurgy. Assaying. Water analysis. Chemical engineering.
Organic chemistry.	Pharmacology. Food analysis.
Petrography, mineralogy, crystallography.	Economic geology. Mining engineering.
Dynamic geology, physiography.	River and harbor improvement.
Historical geology, stratigraphy, paleontology.	Geological mapping and correlation.
Agrogeology (soil science).	Agriculture (in part). Soil mapping and classification.
Biology, or genetics.	Plant and animal breeding. Eugenics.
Systematic botany. Paleobotany.	Economic botany.
Plant morphology and physiology.	Plant pathology, etc.
Plant ecology, sociology and geography.	Agriculture (in part). Forestry.
Systematic zoology. Animal morphology. Paleozoology.	Classification. Taxidermy. Restoration of extinct species.
Animal physiology, ecology and behavior.	Veterinary medicine. Economic entomology and ornithology.
Human anatomy and physiology.	Medicine and surgery. Hygiene.
Psychology.	Psychiatry. Pedagogy. Advertising.
Anthropology, ethnology, archeology.	
Sociology, demography, economics.	Finance. Civics. Legislation.
Geography.	Cartography. Exploration. Regional description.

Very likely it would be better to subdivide the physical, chemical and zoological sections more minutely, or at least differently. For example, it might be well to separate the electricians from other physicists, and the vertebrate from the invertebrate zoologists. In botany, too, the mycologists and bacteriologists have little in common with the students of flowering plants, and might reasonably demand separate sections, unless they are sufficiently accommodated by affiliated societies. Meteorology and climatology, with the related art of weather forecasting, have not been mentioned above, but they should have a separate section, unless their followers are too few, in which case it might be best to unite meteorology with dynamic geology, and climatology with geography.

Of course the more numerous the sections the more papers there will be which would be equally appropriate for two different sections; but this difficulty, which is inherent in all classifications, will be more than offset by the advantages of having the sections more homogeneous, and besides it can be partly overcome by joint meetings, as heretofore.

Incidentally some such classification as the above should serve not only for the purposes of the American Association for the Advancement of Science, but also for the scientific departments of a large university. About the middle of the last century, when the Association had only two sections, in some of our largest institutions of learning all or nearly all the sciences were taught by one or two men, as is done in some small schools to-day. Much more recently botany and zoology were usually included in the same department, and even yet few universities have more than one botanical or zoological department, or a separate chair of geography; the last-named, where taught at all to mature students, being usually combined with geology or even with pedagogy.

ROLAND M. HARPER
COLLEGE POINT, N. Y.

SCIENTIFIC BOOKS

National Antarctic Expedition, 1901–1904. Meteorology Part II., comprising Daily Synchronous Charts, 1 October, 1901, to 31 March, 1904. Prepared in the Meteorological Office under the superintendence of M. W. CAMPBELL HEPWORTH, C.B., R.D., Commander R.N.R. London, published by the Royal Society. 1913. 4to. 26 p., 1003 charts.

This volume completes such physical results of the British National Antarctic Expedition as were specifically taken under the supervision of the Royal Society. It is a monumental work of unusual polar value, and as such

marks an epoch in the meteorological history of the Antarctic regions.

The meteorological conditions of the antarctic and sub-antarctic regions are shown on 883 daily charts, which include 44,893 observations. Cooperation was obtained from 233 ships and 92 land stations, including several observatories. Through the courtesy of the leaders of the German (Professor von Drygalski), Scottish (Dr. W. S. Bruce) and Swedish (Dr. Otto Nordenskiold) Antarctic Expeditions observations were used from Kaiser Wilhelm II. Land, Laurie Island, South Orkneys and Snow Hill Island and Palmer Land.

One hundred and twenty supplementary charts exhibit for each month of the year (and for the year) the mean sea-level pressure and air temperature, with the mean temperature and the mean pressure for each month from October, 1901, to March, 1904.

The wind observations are also summarized in ten tables as to direction and force, arranged according to seasons, to related zones and to oceanic divisions.

Commander Hepworth is justified in setting forth the magnitude of the work, though his statement is questioned that the charts "refer to an area that is far larger than that embraced by any similar set of charts hitherto published." While true as to the Antarctic regions, he seems to have forgotten the daily charts of international meteorological observations, published by the signal corps of the United States army from July, 1878, to June, 1884, which covered the entire northern hemisphere and embodied observations from more than 1,000 regular observers.

The results as set forth by Commander Hepworth are of interest and value. "The average path of all central areas of depressions is found to have been in about the 52d parallel. Between the meridians of 20° E. and 150° E., it was between the 49th and 50th parallels; and between 150° E. and 70° W. in about the 55th." The average rate of travel is about 300 miles per day. One storm, with an average rate of 355 miles daily, was charted through a course of 2,840 miles. It may be added that the assumption of the late Mr. H. C. Russell is confirmed, that to the east of the 30th meridian E., centers of atmospheric depressions usually travel on paths south of the 43d parallel during winter, and south of the 46th parallel in summer.

Of special interest are the conclusions as to the general movements of the atmosphere. Commander Hepworth says: "The interchange of air between equatorial and polar regions may be effected through the intermediary of anticyclonic circulations, albeit these high-pressure systems are permanent; and in my opinion the temperature zones are bridged in this manner."

The charts of mean pressures clearly indicate a seasonal migration of high pressure belts in the Antarctic regions. This action is evidently general. Pointed out by Buchan in a general way, these atmospheric phenomena for the northern hemisphere were definitely set forth by the reviewer in a series of charts, published in Appendix 17, Annual Report of the Chief Signal Officer of the Army, 1891.

An incidental feature of this magnificent work requires notice. The Antarctic map of Volume I., 1908, omitted entirely Wilkes's Antarctic discoveries. The key map of Volume II. contains the legend: "Land reported by Commander Wilkes, U. S. N., 1840." Twelve months prior to the transmittal of the proofs of the introductory remarks, an Australian, Dr. Mawson, had not only visited this "reported" land but had established two scientific stations thereon, and to-day with courage and energy creditable to the British empire adds to the world's knowledge of this vast and ice-crowned continent, so long discredited.

A. W. GREELY

THE BELGIAN ANTARCTIC EXPEDITION

Resultats du voyage du S. Y. Belgica en 1897–8–9, sous le commandement de A. DE GERLACHE DE GOMERY. Rapports Scientifiques. GÉOLOGIE. Petrographische untersuchungen des gesteinsproben, II., VON DRAGOMIR SISTEK. 1912, pp. 20, 1 pl. ZOOLOGIE. Tuniciers caducichordata (Asci-

diacés et Thaliacés) par E. VAN BENEDEN et MARC DE SELYS-LONGCHAMPS. 1913. Pp. 120. 17 pl.

The rocks reported on from the Antarctic are chiefly from Cape Gregory and Elisabeth Island. From the former locality granite and diorite, quartz porphyry, porphyrite, andesite and diabase, with a single specimen of basalt. Metamorphic schist and a quartz-feldspar conglomerate were also represented in the collection.

From Elisabeth Island, diorite, andesite, diabase and mica schist are reported.

The other rocks reported on are mostly from Punta Arenas and other points about the Magellan Straits and are of less interest.

A fine plate gives microphotographs of sections of the more interesting crystalline rocks.

The study of the Tunicates had been nearly completed by Professor Van Beneden when his researches were interrupted by death. But his text was entirely completed only for the Salpas and the plates referring to them. For the rest, notes, sketches, plates, etc., much remained to be coordinated and the text to be prepared by the later editor. With the exception of Plate VIII., all the plates are from figures left by Van Beneden. The classification adopted is that of Hartmeyer.

The Antarctic species collected by the expedition comprise two new species of *Corella* and a single *Boltenia,* which have been exhaustively monographed. The other species, also new, are from the Chilian coast. The Salpas are Antarctic and are the first brought from this distant region. They include one new species and a new variety of *S. fusiformis*.

The plates are of remarkable beauty and the work will add materially to the existing knowledge of the subject.

W. H. DALL

Abwehrfermente des tierischen Organismus gegen körper-, blutplasma- und zellfremde Stoffe, ihr Nachweis und ihre diagnostische Bedeutung zur Prüfung der Funktion der einzelnen Organe. Von EMIL ABDERHALDEN. Second edition. Published by Julius Springer, Berlin. 1913. Pp. ix + 199; with eleven text figures and one plate. Bound M. 6.40; paper covers M. 5.60.

In the second edition[1] of this booklet, the first appeared about one year ago, Abderhalden gives a clearer and more fully developed presentation of a defensive mechanism of the body which his researches have already shown to be of great interest and importance. Briefly stated, Abderhalden believes, on the basis of experimental work, that all soluble members of the proteid, fat and carbohydrate groups produce ferments when they come into contact with an organism's cells which are unaccustomed to their presence. The foreign proteid, for example, may be the characteristic proteid of another species, as when horse serum is injected into a dog, or it may be a proteid which is a characteristic component of the organism itself, but which through some process or other is found in localities where it does not normally belong, as when placental tissue components circulate in the maternal organism. In either case ferments are formed which digest the body-alien or blood-alien proteid. These ferments moreover are not specific when a proteid is injected in the crude laboratory experiment, but they are specific when the body inoculates itself, as for example during pregnancy. This specificity of the resultant ferment has made it possible for Abderhalden and his collaborators to make the differential diagnosis in hundreds of cases between pregnancy and non-pregnancy, practically without error, although many of them were complicated with cancer, salpingitis, tuberculosis, etc. This part of the work has been in general corroborated by other and independent workers. Abderhalden, however, carried the experimental development of this view still further. He argues that as all diseases must necessarily disturb the functional activity of some organ or organs, it is probable that these structures will form abnormal products. These abnormal products when thrown into the blood and lymph stream will act as blood-alien or cell-alien substances and will stimulate

[1] The first edition was reviewed in SCIENCE, 1913, Vol. XXXVII., p. 837.

the production of ferments specifically built to digest these foreign bodies. The test for these ferments is made by permitting the serum of the diseased individual to act upon the tissue of the organ at fault and searching for digestive products. The systematic test of organ after organ against the specific ferments formed would thus show which structure or structures was diseased, for only the pathologically altered organ or organs would undergo digestion.

It also would seem possible to study the interrelation of organs: when one organ is extirpated its absence affects some other structure or structures and causes the formation of abnormal metabolic products which in turn will betray their presence by the occurrence of specific ferments against themselves in the serum. Indeed, Abderhalden considers these defensive ferments, which are possibly formed by the leucocytes, as reagents for the detection of the characteristic structure of cellular constituents, and he justly points out that this conception opens up an enormous field for fruitful investigation.

The experimental technique for the detection of these ferments is full of difficulties. As the ferments themselves can not be isolated, their presence is proven, in the dialysis method, by demonstrating the occurrence of diffusible cleavage products after the serum has acted upon the prepared proteid. This demands a rigid asepsis to prevent bacterial contaminations. In addition there are numerous details upon whose observance Abderhalden emphatically insists. A full discussion of all these points, in fact a complete laboratory guide for the practical worker in this special field, forms an important part of the second edition of the booklet; this section will aid greatly in bringing about a full and rigid test.

From the short statement given above it will be seen that Abderhalden's brilliant development of this view concerning a defensive mechanism of the body has a breadth and promise which fully warrants the interest the scientific medical world has shown.

JOHN AUER

ROCKEFELLER INSTITUTE

Bovine Tuberculosis and Its Control. By VERANUS ALVA MOORE, B.S., M.D., V.M.D., Professor of Comparative Pathology, Bacteriology and Meat Inspection, New York State Veterinary College at Cornell University, and Director of the College. Ithaca, N. Y., Carpenter & Company. 1913.

The title of this book and the name of the author would naturally lead one to expect a complete treatise on this important subject. The book, however, is a distinct disappointment.

It contains 104 pages of matter by Dr. Moore. There is an appendix of 34 pages, which gives the Report of the International Commission on the Control of Bovine Tuberculosis, and following this are 30 plates, which for the most part are excellent.

The scope of the book can be understood by noting the space devoted to the different subjects. "The History of Tuberculosis in Cattle," occupies three and three fourths pages; "Distribution, Economic and Sanitary Importance of Bovine Tuberculosis" takes up nine pages. The "Sanitary Importance," which is included in this chapter, takes up one and three fourths pages. "The Symptoms of Tuberculosis" are given in three and three fourths pages, and so on. There is scarcely a subject which is adequately treated. In view of this, one would naturally look for a great many omissions of important matter, but it is hard to understand how even a cursory history of this subject can be given without referring to the work of the State Live Stock Sanitary Board of Pennsylvania, where for the first time in the world positive proof was given that the bovine tubercle bacillus was transmissible to human beings, this proof being adduced by the method laid down by Koch, namely, the isolation of cultures from persons who had died of the disease and the inoculation of cattle.

In the chapter entitled "The Cause of Tuberculosis," page 17, is sandwiched in some history and the statement that with Koch's announcement in 1901 "there began one of the most intense investigations into the nature of a disease that has ever been recorded."

For the truth of history it should be stated once for all that many investigations on this subject had been under way for years before Koch's announcement. At the laboratory of the State Live Stock Sanitary Board of Pennsylvania studies had been going on for three years previous to this, and at the Congress where Koch made his announcement a paper was read giving the results of these investigations, which to a large extent disproved the assertions of Koch. In 1902 the work from this same laboratory gave the final proof of Koch's fallacies. It is curious that the author of this book should have entirely omitted all mention of this work which has been widely published and certainly is easy of access.

The list of references is made up almost entirely of bulletins from State Agricultural Experiment Stations and the Bureau of Animal Industry, and no general list of useful papers on this subject is given. Among the references, Bulletin No. 75, Pennsylvania Department of Agriculture, 1901, is credited entirely to Pearson. It was a conjoint publication by Pearson and Ravenel.

The book lacks sequence. For instance, under "Method of Dissemination" in a summary by Peterson "on the finding of tubercle bacteria in the milk and excreta," on page 34, we find Abbott and Gildersleeve quoted on the relation between tubercle bacilli and other members of the acid-fast group.

Although Bulletin No. 75, Pennsylvania Department of Agriculture, is given as a reference, it is evident that the author gave as little attention to the contents as he did to the title. In the summary concerning the finding of tubercle germs in milk, which he quotes, he has entirely omitted the work given in that bulletin. This was quite an extensive piece of work, done with unusual care, and was among the first carried out in the United States on this point.

In a subsection on "Channels of Infection" we find the buying in of diseased cattle and infection through creamery and cheese factory by-products given—certainly not channels of infection.

The best chapter in the book, exclusive of the report of the International Commission on Bovine Tuberculosis, is that on Tuberculin, which occupies nine pages.

These criticisms will show that the book is not one that can be recommended, and it should not be dignified with the title which it carries. It might pass as an experiment station bulletin, but nothing more. It is to be regretted that the "cacoethes scribendi" will run away with the judgment of good men, and lead to the publishing of such a book as this.

MAZŸCK P. RAVENEL

UNIVERSITY OF WISCONSIN

Catalogue of the Lepidoptera Phalænæ in the British Museum. Vol. XII. By SIR GEORGE F. HAMPSON, Bart. London. 1913. Pp. xiii + 626.

This volume contains the continuation of the family Noctuidæ, already partly treated in Volumes IV. to XI. of these catalogues. A part of the subfamily Catocalinæ is covered. A key to the genera is given, which will be reprinted in a more complete form in the next volume. Sixty-three genera with 643 species are fully described and a large proportion figured in colors in the accompanying book of plates, numbered CXCII. to CCXXI. The definition of the group, based on the presence of spines on the mid-tibiæ is somewhat artificial, as the author admits, but will probably not cause confusion in many cases. Otherwise it would be necessary to include this group in the already large subfamily Noctuinæ. The treatment is similar to that already familiar to us in the preceding volumes and is a welcome addition to this indispensable work.

HARRISON G. DYAR

SPECIAL ARTICLES

SOME EFFECTS OF THE DROUGHT UPON VEGETATION

THE summer of 1913 was exceedingly dry and hot in many parts of the United States, but the combination of climatic and edaphic factors which produce that complex effect included under the term *drought* appeared to center in southeastern Nebraska, eastern Kansas, northwestern Missouri and southeastern Iowa. Lines of extremely xerophilous condi-

tions radiated from this general axis for several hundred miles in nearly all directions.

During this period there were a number of days when Lincoln, Nebraska, experienced the highest temperature recorded by the eighty or more stations of the U. S. Weather Bureau which report to the Lincoln office. The dry period began at Lincoln on June 8 and continued until about September 8. According to the director of the Lincoln section of the Weather Bureau only 2.84 inches of precipitation was recorded for this period. This represents but twenty-five per cent. of the normal rainfall for this time at this station. Almost one half of this amount fell in such small quantities as to be of little benefit to vegetation. Weather records have been kept at Lincoln for thirty-two years and this is the lightest rainfall ever recorded for ninety-two days at this time of year. The normal precipitation for this period is 11.33 inches.

The temperature was high for the last part of June and the first half of July, but the first of the higher temperatures were recorded between July 13 and 17. These five days were very hot, the maximum temperature ranging from 102° F. to 109° F. More moderate temperature followed these first blistering days for about one week and then the remarkable hot period began. High temperatures prevailed with hardly a break from July 26 to September 7 or 8. During these forty-four days there were twenty-three days when the maximum temperature was 100° F. or more and it was below 90° F. on only seven days. On an additional number of these days the temperature went to 97° to 99° F. During the whole period from June 8 to September 8 there were twenty-nine days with a temperature of 100° F. or higher.

The relative humidity was low at various times during this long-continued "hot wave" and the conditions favoring desiccation were accordingly greatly magnified. Add to all these rigorous climatic conditions the influence of a strong wind which prevailed at times during the heated season and this region was at the mercy of the most extremely dry and protracted summer weather on record.

The most important effect of the drought is reflected in the greatly reduced yield of a number of the leading field, forage and garden crops, the products for which the territory is renowned. Fortunately the yield of winter wheat was not seriously impaired because that grain was so far advanced toward maturity at the beginning of droughty conditions that there was plenty of moisture in the soil (from a very promising spring) to satisfy the needs of that particular crop. In fact it appears that the yield of winter wheat for the year 1913 was considerably in excess of the average for practically all of the drought-stricken territory west of the Mississippi.

The second and third cuttings of alfalfa were, however, much less than normal for the region as a whole. Some farmers secured a very low return from the third crop of this legume. The yield of potatoes and other less important garden vegetables was also greatly affected by the hot dry days of the latter part of the vegetative season, although in certain parts of the region potatoes are yielding heavily.

Corn was the crop which suffered most, and, since the prosperity of the country is so often figured with reference to the yield of this crop, the effects of the drought appear unusually severe. Except in a few portions of this state (Nebraska) the yield of "King Corn" was very greatly diminished and in some parts, where at least *some* corn usually grows, absolutely no corn will be harvested.

One of the most noticeable effects of the drought upon the native plant life was seen in the shortening of the period of vegetative growth and in the hastening of flowering and fructification. This was noted especially with various herbaceous plants which apparently completed their summer activities several days or weeks earlier than usual. Early leaf maturity and leaf fall was common among native and exotic forest trees. In some cases almost all of the leaves had fallen by the end of July, while in nearly all of our trees noticeable early leaf fall was characteristic. Trees especially conspicuous in this regard in Lincoln were the

hackberry, *Celtis occidentalis;* elm, *Ulmus americana;* and Carolina poplar, *Populus.* These trees also showed great variations in the condition of their leaves, some individuals being nearly leafless at the same time (August) that others were quite normal. Many gradations occurred between these two extremes. The ash, *Fraxinus lanceolata,* was apparently affected to the least degree of all of our commoner tree species. Street trees in general suffered greatly and many such individuals perished during the summer. One man, the owner of a very attractive home and grounds in another city of the state, told me that he had kept three lines of hose constantly pouring water into the ground about his trees throughout the summer and that even then some of the trees were affected by the dry weather.

Toward the close of the summer it was noted that a number of the trees that had lost practically all of their earlier leaves had developed many new bright green leaves, which, however, were much smaller than the typical leaves of the species. The most conspicuous examples of this phenomenon occurred in the hackberry and in the Kentucky coffee tree, *Gymnocladus dioica.* Some trees of the former species put forth practically a full number of new leaves, but the small size of the late leaves made such trees rather noticeable. Many clusters of short compound leaves with very small leaflets appeared upon the almost bare, club-like branches of the coffee tree. In this case the new leaves came from dormant buds situated at some distance below the shoot apices.

Native woods along the streams of the eastern part of Nebraska were unusually dry and barren. The usual mesophytic undergrowth was greatly reduced in volume and few species of the usual summer and early autumn fungi were to be seen. The rich soil of the more open parts of such woods became as dry and powdery as that of the fields and some of the moisture-demanding plants of such habitats dried up and disappeared long before the usual time. Many of the spring-fed streams of the woodlands disappeared completely and the ravines became desiccated to a very unusual degree.

Native pastures suffered greatly and after July 15 little or nothing of forage value was to be found in such places. The ground became very dry and in some places broke into great blocks of extremely hard soil with prominent fissures between the solid masses.

The dryness of native vegetation and fields along the railroads resulted in the starting of an unusual number of fires by sparks from passing locomotives. Such blazes destroyed considerable grain in the shock or stack and in at least one case resulted in the death of a farmer and several of his horses. During a trip across the state early in September it was noted that many fires had been kindled in this manner so that the railroad right-of-way and sometimes for considerable distances on either side the grass or stubble had been destroyed by fire for long distances. Groves of planted trees or rows of trees along the railroad were frequently damaged or completely killed. This indirect effect of the drought seemed to be unusually common in many parts of the drought-stricken territory.

As cooler and moister weather succeeded the trying drought numerous cases of renewed activity on the part of vegetation were evidenced. The most pronounced late season reaction of this sort was observed in the re-greening of lawns, pastures and roadsides which had appeared as areas of stubble for so many weeks. The fresh green of early October is most welcome evidence of the fact that vegetation was not entirely burned out under the protracted desiccation of the long summer weeks.

Examples of the autumnal flowering of trees have been noted in greater than usual number. That this phenomenon is not induced in all cases by the succession of moist weather after a period of drought (as is commonly supposed) is shown in the case of a cherry tree on the campus of the University of Nebraska. This cherry tree, *Prunus padus,* came out with its second production of flowers early in September before the drought had been "broken." A striking additional peculiarity of the serotinal flowers of this species was seen in the presence of many abnormalities or malformations. Phyllody of various flower parts was especially common. Many of the racemes were in fact

transformed into veritable museums of teratological specimens.

RAYMOND J. POOL
THE UNIVERSITY OF NEBRASKA,
October 10, 1913

AN ANCESTRAL LIZARD FROM THE PERMIAN OF TEXAS

THERE has been no more vexed problem in vertebrate paleontology than the origin of the scaled reptiles. The theory generally accepted has been that the lizards arose from the double-arched or rhynchocephalian type by the loss of a primitive lower arch, a theory of which I have been skeptical for many years past. I have urged in various publications for the past ten years that the lizard phylum is a very ancient one, predicting that it would eventually be discovered in the Permian, a prediction that I am now able to verify. Three years ago I described briefly a peculiar reptile from the Lower Permian of Texas under the name *Arœoscelis.* It has only been recently that the stress of other material has permitted the full preparation of the several more or less complete skeletons upon which the genus was based, a study of which has disclosed more decisively than in any other American Permian reptile the structure of both skull and skeleton. *Arœoscelis* was an extraordinarily slender, long legged, cursorial and arboreal reptile of about eighteen inches in length. The skull is remarkably lizard-like in appearance and structure, with a typical upper temporal vacuity bounded precisely as in the mosasaurs. The sides of the skull below the arch, instead of being open, as in the lizards, are covered over by a broad expansion of the squamosal bone, which is rather loosely united to the quadrate. The quadrate is supported, as in lizards, by the tabulare and opisthotic; it is rather free and is broadly visible from behind. The lacrimal bone is small, as in lizards, a character hitherto unknown among ancient reptiles; and the palate has rows of teeth on all the different bones. The neck has seven or eight more or less elongated vertebræ, the dorsal region twenty. The sacrum is almost indistinguishable from that of lizards. The pectoral and pelvic girdles differ chiefly in their old-fashioned characters. The tail was slender and long. The feet have an elongated calcaneum and a reduced astragalus, unlike those of the known contemporary reptiles. Finally the attachment of the ribs, one of the most peculiar characters of the Squamata, is by a dilated head, articulating with both arch and centrum.

To convert *Arœoscelis* into a modern lizard would require the reduction of the squamosal bone from below to a slender bone articulating with the postorbital; the closer fusion of the postorbital with the postfrontal; the greater freedom of the quadrate; the loss of the posterior coracoid bone and a modernizing of the girdles, every one of which characters we are quite sure must have been present in the ancestors of the Squamata.

Arœoscelis can not be placed in any known order of reptiles, unless it be admitted to the Squamata. But, I do not think that the differences from the Squamata will justify its ordinal separation, if we are to classify organisms phylogenetically. I would rather modify the definition of the order Squamata to include the genus as the representative, doubtless with *Kadaliosaurus* also, of a distinct suborder, the *Arœascelidia.* Several years ago I recognized in another Permian vertebrate a primitive salamander, bearing about the same relations to the modern Urodela that *Arœoscelis* does to the modern lizards. The urodelan character of *Lysorophus* has now been generally accepted, and I believe that after I have published the full details of the structure of *Arœoscelis* I shall find concurrence in its phylogenetic association with the Squamata.

I regret much to add that Dr. Broom's inexperience with the American Permian vertebrates has led him into several errors in his recent discussion of the affinities of *Arœoscelis,* based upon the meager details which have been published. Had he heeded Dr. Case's warning I do not think he would have so readily assumed that the skull and skeletal bones which he described as *Ophiodeirus* really belong together. They probably do not, for

the skeletal bones are those of *Aræoscelis,* as he himself suspected. It is unnecessary to add that his conclusions, based upon erroneous premises, are wholly incorrect. *Aræoscelis* is as widely separated from *Bolosaurus* as is any other known American Permian reptile, at least so far as can be judged from the skull as Dr. Broom has restored it.

S. W. Williston

University of Chicago,
November 8, 1913

THE CONVENTION OF GEOLOGISTS AND MINING ENGINEERS

In connection with the National Conservation Exposition conducted in Knoxville, Tennessee, during September and October, there was held a meeting of geologists and mining engineers for the purpose of discussing problems connected with the conservation of the natural resources of our country and especially of the south. Delegates were present from most of the southern states and many from the north and west.

The papers and discussions were of a high order and it is hoped that arrangements can be made to have these in print at an early date. Following are the titles of papers read:

"Economic Non-metallic Minerals of the Southern States," by Dr. J. Hyde Pratt.

"Inventory of the Mineral Resources of Georgia," by S. W. McCallie.

"Conservation as Applied to Mining Lime Phosphates," by E. H. Sellards.

"The Regulation of Oil and Gas Wells, Especially When Drilled Through Coal Seams," by Richard R. Hice.

"The Iron Resources of the World," by Dr. E. A. Schubert.

"Possible Dangers to Mines in Drilling for Oil and Gas in the Coal Measures," by Edward Barrett.

"The State Geologist and Conservation," by Dr. A. H. Purdue. (Read by title.)

"Oregon Problems of Resource Development," by H. N. Lawrie.

"Relations of the Forest Service to the Conservation of Mineral Resources of Mineral Lands," by Don Carlos Ellis.

"Soil Survey and Conservation *vs.* Soil Mining," by H. A. Hard.

"The Conservation of Natural Gas in the Mid Continent Field," by C. N. Gould.

"Gypsum and Salt Deposits of Southwest Virginia," by F. A. Wilder. (Read by title.)

"Scenic Beauty and Its Variation as Influenced by Geological Origin," by George F. Kunz. (Read by title.)

"Sane Development of the Mineral Resources of the South," by E. J. Watson. (Read by title.)

C. H. Gordon was elected chairman of the convention and F. W. DeWolf, state geologist of Illinois, secretary.

The following resolutions were adopted:

Whereas, The burden of classification of our public domain rests heavily, and perhaps unjustly, on the applicant desiring to title such lands, and

Whereas, Many conflicting interests with the consequent loss and embarrassment to the land and mineral claimant results from an absence of adequate classification of the federal domain, and

Whereas, There are not sufficient funds available for the purpose of expediting the work of classifying the federal domain, and

Whereas, It is recommended by this convention of geologists and engineers assembled at the National Conservation Exposition, at Knoxville, Tennessee, September 19, 1913, that this work be accelerated, and that the same should be comprehensive so as to include the possibilities of agriculture, timber, hydro-electric and mineral development and, if practicable, simultaneously; be it therefore

Resolved, That we, the members of the convention of geologists and engineers assembled, memorialize Congress of the United States to increase this appropriation sufficiently to enable the work as herein noted to be carried out efficiently by the Departments of the Interior and Agriculture.

Whereas, There has been an extended argument concerning the merits of state versus federal control of the national forests; and

Whereas, The Oregon Conservation Commission has made an exhaustive study of this subject, which resulted in their conclusion in favor of federal ownership; be it therefore

Resolved, That we, the members of this convention of geologists and mining engineers, assembled at this National Conservation Exposition at Knoxville, Tennessee, September 19, 1913, do hereby endorse the findings of the Oregon Conservation Commission in favor of the federal ownership of the national forests.